S. HRG. 99-293

CLEAN COAL TECHNOLOGIES

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

NINETY-NINTH CONGRESS

FIRST SESSION

ON THE

DEPARTMENT OF ENERGY'S REPORT TO CONGRESS
ON EMERGING CLEAN COAL TECHNOLOGIES

MAY 16, 1985

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CLEAN COAL TECHNOLOGIES

Thursday, May 16, 1985

U.S. SENATE,
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:13 p.m., in room SD-366, Dirksen Senate Office Building, Hon, John W. Warner, presiding.

Present: Senators Warner, Hecht, Ford, Metzenbaum, and Rockefeller.

Also present: Paul Gilman and Marilyn Meigs, professional staff members; Benjamin S. Cooper, professional staff member for the minority; and James T. Bruce, counsel for the minority.

OPENING STATEMENT OF HON. JOHN W. WARNER, A U.S. SENATOR FROM THE STATE OF VIRGINIA

Senator WARNER. Today the subcommittee will be holding this hearing to discuss the results of a recently released report to Congress by the Department of Energy entitled "Emerging Clean Coal Technologies." The report was conducted as a result of a provision placed in the Department of the Interior's appropriation act for fiscal year 1985 requiring the Secretary of Energy to solicit from the private sector statements of interest and proposals for projects employing clean coal technologies.

We have today Secretary Vaughan who will present testimony on behalf of the administration.

In addition, Mr. Reichl, Chairman of the Clean Coal Technologies Panel for the Energy Research Advisory Board, will be here to discuss a separate report conducted concerning emerging clean coal use technologies.

Following comments from Mr. Vaughan and our other witnesses, we will have representatives from the Electric Power Research Institute and others.

As we all know, coal is one of our most abundant energy resources. I believe we should develop it and promote its use here and abroad. Obviously, we want to do what is necessary for not only a sound environment, but also to strengthen our national defense.

I understand we have received several statements for the record, and I will announce now that the record will remain open for 10 days following this hearing for anyone else wishing to submit testimony.

Senator Ford.

STATEMENT OF HON. WENDELL H. FORD, A U.S. SENATOR FROM THE STATE OF KENTUCKY

Senator FORD. Thank you, Mr. Chairman.

Earlier this week the Department of Energy testified before the subcommittee in support of the nuclear energy option. I am in basic agreement with the Department's position on the nuclear option. The Department testimony made some telling points on the development of technology.

Today I want to hear if DOE maintains the same position with respect to the coal option. I hope for consistency, not disappointment.

The Department's points on Tuesday were these: Should we, as some have suggested, abandon our nuclear energy research and development program and just put the current nuclear technology on the shelf for use when it is needed in the future?

Current technology, as good as it is, must be augmented to meet the intermediate and long term needs of the Nation.

Even the best of technologies cannot be effectively utilized without the industrial infrastructure and skilled personnel necessary to make it work.

What is needed is a cooperative effort among the nuclear industry, the utilities and Government for the purpose of completing design of advanced plants using state-of-the-art technology and obtaining certification of these designs.

And last, history teaches us that the effective application of any basic technology requires both continuing deployment, experiencing concurrently with focused research and development to enable improvements in the future.

Mr. Chairman, these points hold true for me on coal technology, and that is why I am here today, to hear if they also hold true for the Department of Energy.

Senator WARNER. I thank you, Senator Ford.

I might also mention that the origin of this hearing being in that special piece of legislation, Senators Byrd of West Virginia, the chairman of this committee, yourself, myself and others got behind that amendment to see that it happened.

The Senator from Ohio.

STATEMENT OF HON. HOWARD M. METZENBAUM, A U.S. SENATOR FROM THE STATE OF OHIO

Senator METZENBAUM. Mr. Chairman, first let me commend you for holding this hearing because I believe that coal is such a fantastic energy resource in this country, and I think we are literally letting it slip between our fingers as far as its utilization and as far as its development is concerned.

And there isn't any secret about it. The whole issue relates so much to the matter of clean coal technology. We have enough coal to last us more than 200 years, but if we can't use it and people aren't willing to use it, then it will not be that meaningful to the economy, nor will it be that useful as far as a substitute for other energy resources.

If we can improve utilization of coal so that it can be clean and economical, it will have an unbelievable value to our economy, our environment as well as employment.

In my own State of Ohio, coal production has fallen from 55 million tons in 1970 to 33 million tons in 1983. And direct unemployment in the Ohio coal fields today is over 10,000 people, and that's without taking into account those who are impacted or affected by reason of the direct number of people unemployed.

The big factor in the decline is the sulfur content of the coal. So economic removal of sulfur is crucial to the future vitality of the coal industry in my State. The successful development and implementation of clean coal technologies is important and is vital to Ohio.

Now, the State itself has set up an aggressive program to address the issue. In fiscal year 1984, $1.3 million in State funds were granted to eight projects, and that leveraged another $6.2 million in private sector cosponsorship. That's an indication of commitment and concern, but Ohio can't do it alone. The problem is bigger than those dollars and bigger than the State of Ohio can adequately address.

It needs and deserves the help of the Federal Government. The success of clean coal technologies will not only benefit Ohio but the entire Nation.

Now, even the Department of Energy's own Energy Research Advisory Board has recognized the importance of coal in our energy future and has recommended that Federal coal R&D spending be doubled. Yet the Department of Energy has put on its ideological blinders again. Over the past 4 years, the fossil energy research budget has literally been emasculated. In fiscal year 1981 our fossil energy budget was almost $1 billion. Today the Department recommends a fossil energy budget of $157 million.

There may have been some waste in the 1981 budget, but can anyone say with a straight face that our fossil energy R&D program should have been cut by almost 850 percent in a period of 5 years? Unfortunately, DOE seems oblivious to the near- and long-term value of successful development of clean coal technologies. They overlook how much we would save if we can displace oil imports which are costing us about $60 billion a year. They ignore the opportunity to avoid the costly and devasting impact that acid rain has had on our lakes and forests and the threat this problem poses to utilities and miners in the Midwest. They fail to see the tremendous potential for expanding our economy and increasing jobs by encouraging the direct utilization of coal.

This administration seems willing to mortgage our future in order to save a few pennies today.

Mr. Chairman, not only is the Department of Energy guilty of poor planning, it has simply not obeyed the law. In the 1985 interior appropriations bill, we specifically ordered DOE to review and assess the range of clean coal technologies. We didn't get that. The report submitted to Congress only provided a generic review of clean coal technologies and did not assess any of the 176 proposals submitted to them.

Congress wanted some help in selecting the most promising technologies. Instead we get a statement from DOE that it is not likely that any of the $750 million will be awarded.

Now, I have to ask, who suddenly delegated the power of appropriation to the Department of Energy?

Mr. Chairman, I must admit, Congress also shares part of the blame. It is up to us to appropriate any or all of the $750 million in the clean coal reserve. If we are serious about this program, we should appropriate the money and ensure it is spent wisely and effectively. We are in a good position to move this program forward because the chairman and ranking minority member of the full committee, Senators McClure and Johnston, hold the same positions on the Interior Appropriations Subcommittee. And I hope that when the subcommittee begins markup, funds will be allocated for this program. It would be the right thing to do for our economy, it would be the right thing to do for our Nation, it would be the right thing to do vis-a-vis the question of balance of payments. It would be the right thing to do as far as our Nation's future security is concerned.

And I see no reason not to go forward. And I very much appreciate your interest and concern, Mr. Chairman.

Senator WARNER. I thank the distinguished Senator from Ohio, and indeed, I wish to associate myself with the concluding parts of your speech because as I read through the submissions from the Department of Energy, there is an implication that the bottom line is that no Federal funding is necessary, and I hope that we can convince our principal witness to change that view, if in fact it is correct.

The Senator from Nevada.

Senator HECHT. Thank you, Mr. Chairman, no statment.

Senator WARNER. The Senator from West Virginia.

STATEMENT OF HON. JOHN D. ROCKEFELLER IV, U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

Senator ROCKEFELLER. Thank you, Mr. Chairman.

As a relatively new Senator, as Wendell Ford points out to me about once a week. [General laughter.]

Senator FORD. What is your number, Senator?

[General laughter.]

Senator WARNER. Worry not about the number. You are no stranger to coal, Senator Rockefeller.

Senator ROCKEFELLER. That's right. It is not my habit to make opening statements, and I have not made any opening statements in the months that I have been here. But today is different, Mr. Chairman, very, very different, and I want to compliment you, personally, for calling this hearing to review and consider the Department of Energy's report to the Congress on emerging clean coal technologies. It is, obviously, an issue of critical and timely importance to my State of West Virginia, and I would argue, of paramount importance to Americans' energy policy and energy security.

The United States has the good fortune to sit on top of a massive natural resource known as coal. It is a resource that we have

barely begun to tap and a resource that will be fueling our industry and lighting our homes long after we are no longer here.

Those who developed this abundant resource, the American coal industry, especially in the eastern United States, and specifically in Appalachia, that particular industry is in dire straits. The strength of the dollar has killed our coal export trade. The rapid decline of the American steel industry has slowed the growth of coal and coke demand. The transportation costs have decreased the competitive edge of domestic coal.

And in addition, like in steel, like in autos, like in high technology, the coal industry is braced for a growing threat of coal and electricity imports which we are already seeing in substantial amounts.

All in all, it is a prescription for one more failure in energy policy and domestic economics if we allow our domestic coal resource to go the way of other industries, and it would be yet another devastating blow to my State of West Virginia.

Therefore, development of a clean coal technology program provides a very positive note in this entire scenario. Through the efforts of the distinguished senior Senator from the State of West Virginia, Senator Byrd, the Congress last year did in fact authorize a clean coal technology reserve of $750 million, and mandated the report that the committee reviews on this day.

I think there is substantial reason for encouragement when, in a short period of time, more than 175 projects can be put forward. Although a few of these have emerged from ongoing existing research work, a substantial number of them are in fact fresh, are demonstration concepts for applications in utilities, steel mills, industrial applications and other uses.

To sound a discouraging note, however, I view as unacceptable and outrageous the contention by the Department of Energy in its report that stepped up Federal support of clean coal technologies would be "counterproductive to their development." Since the Department of Energy has provided little more than ideological balderdash to support this view and respected coal experts have concluded entirely the opposite, I can only guess that this is just one more example of where this administration has chosen to put its head in the sand and wear its free market blinders with regard to America's long term energy security.

Mr. Chairman, clean coal technologies represent more than a choice of energy policy or energy research. They are an essential ingredient in decisions about environmental policy. They are also vital technologies with respect to the choices that we make on utility growth or nongrowth. In addition, clean coal technologies may well prove to have an impact on our trade policies in steel, in coke, and in coal.

Make no mistake about it: This is the crossroads for the struggling American, and especially Eastern, coal industry. Down the existing road the coal industry finds itself in the crosshairs of increasingly stringent environmental pressures, worsening coal exports, and a threat of significant coal imports. Down the road of an accelerated clean coal program, the coal industry as well as the utility industry, environmentalists and energy policymakers, can find a more positive, more secure energy choice.

Mr. Chairman, in my judgment we simply must fund the Clean Coal Technology Program. We simply must make the wise decision to secure America's energy future by improved and expanded use of our abundant coal reserves. We simply must get this process started in a timely way.

I, as others, look forward to today's hearing, and once again, Mr. Chairman, I commend you as always for your efforts on behalf of coal.

Senator WARNER. I thank the distinguished Senator from West Virginia. He speaks with eloquence and a base of knowledge and fact.

I share your views.

We are about to start a classic confrontation of who is going to be king on top of the mountain, and unless DOE joins us, we'll be king and we'll construct our own program and find somebody to implement it.

Now, to lead off this afternoon, we have the distinguished Senator from Montana, and we will hear from our colleague first.

No doubt if Jennings Randolph were here today, he would be the lead-off witness, but we have an equally eloquent and knowledgeable person from a very important coal State.

STATEMENT OF HON. MAX BAUCUS, A U.S. SENATOR FROM THE STATE OF MONTANA

Senator BAUCUS. Thank you, Mr. Chairman. My statement is along the lines of those Senators who have just spoken.

I think it's important to realize where we are today. Coal has been an important energy resource since the dawn of our country. For the past 200 years, we have used coal.

We are blessed with abundant resources of coal. We have over 300 billion tons of coal. We have enough coal that can be used for 300 more years in addition to the past 200 that we have used.

The Senators from Ohio, the Senators from West Virginia and Kentucky have pointed out the balance of trade deficit we now have. It seems to me, Mr. Chairman, that coal should be utilized more than it has been utilized, and the question is, why are we not using more coal?

Well, there are two reasons why coal has been used inefficiently, and there are two ways we can make coal more effective. No. 1 is to use only low sulfur coal. This country could burn more coal, more efficiently, more cleanly, if we used only low sulfur coal. But obviously that is not going to happen. We have high sulfur coal producing areas, we have low sulfur coal producing areas. The percentage reduction requirement in the Clean Air Act, I think, has a bias toward high-sulfur coal, has a bias against low-sulfur coal, but that is in the law, and there's not much we can do about that, although we should.

So we are not going to be able to burn more low sulfur coal.

The other option, the other way to utilize more coal more efficiently, more cleanly, is to use scrubbers. Well, we all know that scrubbers are very costly, in many ways, very ineffective, and it is just an added cost of doing business, and that makes it more difficult to burn coal.

So it seems to me, Mr. Chairman, we should try a third option if we are blessed with all this coal, and that, namely, is invest in research and development to develop clean coal technologies.

Nothing could be simpler, and I am frankly astounded that the administration does not come up here with that kind of a recommendation. The Senator from West Virginia alludes to it, the Senator from Ohio alludes to it, the Senator from Kentucky alludes to it, and the fact of the matter is that being blinded by the total free market ideology, think only——

Senator WARNER. You might throw in a Republican, too, along the way.

Senator BAUCUS. And Mr. Chairman, I might add, including the chairman of the committee, which I appreciate very much, that we are tying ourselves, we are sticking our heads in the sand. We are not looking at the future. This country is going to slide comparative to the strength of other countries, unless we spend more effort in research and development.

And I mean not only military R&D; I mean civilian R&D. American civilian R&D as a percent of gross national product is much lower than it is in Japan, much lower than it is in other countries. Why is that? It is because basically we tend to think too much only in the present, too much in the short term. Our budget cycles are only 1 year. We don't think long term. Those other countries tend to think more in the long term. Certainly Japan does.

The fact of the matter, as I can report to you, Mr. Chairman, it is not directly on target, but a few months ago, when I was in Japan talking to the Long Term Credit Bank in Japan, they are investing solely in long term investments. What are they? They are ceramics, they are exotic metals, in the United States, I might add, R&D, research and development efforts, because they see the long term, they see the future.

I agree it is not specifically coal, but they are looking down the road to the future. When I say ceramics, I don't mean pots, I mean industrial ceramics, automobile engines and so forth.

So I am urging the committee, the subcommittee, the full committee, to invest in the future, not in the past, and I strongly support that clean coal technology investment is an investment in the future.

I might add, Mr. Chairman, that a good example of the use of this, too, is in MHD, magnetohydrodynamics. As you may know, Mr. Chairman, MHD is a process that has been with us for several years but has not been funded fully. It has not been given a chance. The Soviet Union is developing MHD. There is some R&D in this country, but there has not been enough.

MHD is cleaner than conventional coal-fired facilities, and is 50 percent more efficient. Nobody denies that, nobody denies that. And in addition to that, private industry is putting its money where its mouth is. It is willing to put up on a 1 for 1 basis its own money along with some Federal investment here to develop a commercial demonstration facility. That is over a 5-year period.

So I strongly urge you, Mr. Chairman, to invest in the future, fund R&D because this country is only going to grow and develop, develop these technologies if we do so. And if we don't, we're going to pay the price.

Thank you, Mr. Chairman.

Senator WARNER. Thank you. The committee welcomes your testimony.

Senator BAUCUS. Mr. Chairman, I also have a prepared statement which I would submit for the record.

Senator WARNER. Without objection.

Senator BAUCUS. And also an article from a Montana newspaper.

Senator WARNER. Again, we thank you, Senator, for taking the time to join us today, and your contribution will constitute a very important part of the record of our deliberation.

[The prepared statement and article submitted by Senator Baucus follows:]

STATEMENT BY
SENATOR MAX BAUCUS
CLEAN COAL TECHNOLOGIES HEARING
MAY 16, 1985

I COMMEND THE CHAIRMAN FOR HOLDING THIS IMPORTANT HEARING.

FOR MORE THAN 200 YEARS, COAL HAS BEEN AN IMPORTANT ENERGY SOURCE FOR AMERICAN INDUSTRIES.

TODAY, MOST OF THE NATION'S ELECTRICAL POWER IS PRODUCED BY BURNING COAL.

YET, DESPITE DECADES OF USE, WE HAVEN'T FOUND A WAY TO BURN COAL CLEANLY AND EFFICIENTLY.

AIR POLLUTION

THE RESULT IS THAT TODAY WE ARE FACED WITH A SERIOUS POLLUTION PROBLEM: ACID RAIN.

ACID RAIN IS FORMED WHEN SULFUR DIOXIDE EMITTED FROM COAL-FIRED ELECTRICAL GENERATING PLANTS COMBINES WITH PRECIPITATION TO FORM DILUTED SULFURIC ACID.

Each day the evidence of damage from acid rain grows clearer. And it is spreading to the West. A recent study by the World Resources Institute pinpointed acid rain damage in the West.

Solving the Problem

Currently, there are two main ways to prevent further damage.

One way is for coal-fired electrical generating plants to switch to low sulfur coal.

The second option is for plants to install scrubbers. But coal scrubbing is very costly, wastes energy and may lead to other environmental problems.

Better Solution

There is a better solution.

But the federal government, specifically the Department of Energy, wants to put this solution on the back burner. They don't want to be bothered.

I SAY, THE TIME HAS COME FOR THE UNITED STATES TO RECOGNIZE COAL FOR WHAT IT IS.

ON THE ONE HAND, IT'S OUR MOST ABUNDANT DOMESTIC ENERGY SOURCE. THE RECOVERABLE RESERVES OF 300 BILLION TONS WILL LAST 300 MORE YEARS AT CURRENT USAGE RATES.

BUT IT'S A DIRTY FUEL. IT'S A MAJOR POLLUTER.

IF WE ARE GOING TO CONTINUE USING COAL, WE MUST FIND WAYS TO BURN IT MORE CLEANLY AND EFFICIENTLY.

THAT MEANS, THE FEDERAL GOVERNMENT MUST MAKE A COMMITMENT TO DEVELOPING CLEAN COAL TECHNOLOGIES.

DOE REPORT

THE DOE REPORT WE ARE EXAMINING TODAY IS DISTURBING BECAUSE IT DOES NOT CONTAIN A COMMITMENT TO CLEAN COAL TECHNOLOGIES.

IT ALSO SEEMS TO REVERSE PREVIOUSLY-HELD POLICY AT DOE ON ONE CLEAN COAL TECHNOLOGY -- MHD (MAGNETOHYDRODYNAMIC POWER GENERATION).

LET ME QUOTE FROM THE REPORT:

"HISTORICALLY, THE U.S. OPEN CYCLE MHD PROGRAM WAS FOCUSED ON COMPONENT DEVELOPMENT. IN FY 1985, THE HISTORIC PROGRAM WAS REDIRECTED BY THE DEPARTMENT OF ENERGY TO A MULTI-YEAR MHD PROGRAM TARGETED ON THE ACHIEVEMENT OF PROOF-OF-CONCEPT (POC) TESTING OF A 50 MW (MEGAWATT) TOPPING CYCLE AND AN INTEGRATED 28 MW (MEGAWATT) BOTTOMING CYCLE.

"FISCAL CONSTRAINTS AND A REASSESSMENT OF DOE PRIORITIES FOR FOSSIL ENERGY TECHNOLOGIES RESULTED IN A DETERMINATION NOT TO REQUEST FUNDS FOR THE MHD PROGRAM IN FY 1986."

A SHIFT AWAY FROM SUPPORTING RESEARCH INTO MHD AND OTHER CLEAN COAL TECHNOLOGIES IS A MOVE IN THE WRONG DIRECTION.

WE NEED A COMMITMENT AT THE NATIONAL LEVEL TO GET THESE TECHNOLOGIES OUT OF THE RESEARCH FACILITIES AND INTO THE POWER PLANTS.

MR. CHAIRMAN, I KNOW YOU ARE COMMITTED TO ADDRESSING BOTH OUR AIR QUALITY AND ENERGY NEEDS. I HAVE A MORE DETAILED ANALYSIS OF THE ENVIRONMENTAL BENEFITS OF MHD THAT I WOULD LIKE TO SUBMIT FOR THE RECORD.

I LOOK FORWARD TO WORKING WITH YOU AND SENATOR MCCLURE TO INSURE A CONTINUED COMMITMENT AT THE DEPARTMENT OF ENERGY TO SUPPORT CLEAN COAL TECHNOLOGY RESEARCH AND DEVELOPMENT.

THANK YOU.

MHD COAL COMBUSTION -- AN ENVIRONMENTAL ANSWER

Some people consider the combustion of coal for the production of electrical power to have negative environmental impact. Because coal is the United States' major energy resource, in the near term its use is a necessity to accomplish energy independence. The primary effluents from coal combustion are sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulates. Typically, SO_x emissions are controlled by either flue gas treatment (e.g., wet scrubbers) or changes in fuel sulfur content (e.g., coal cleaning or low-sulfur coal); NO_x emissions are controlled by combustion controls and the particulates are controlled by collecting devices (e.g., baghouse or electrostatic precipitators). Advances are being made in add-on emission control capability to existing plants (e.g., dry scrubbing techniques, additive injection, electron-beam scrubbing and catalytic units), while other technologies (e.g., fluidized-bed combustors and coal-gasification/combined-cycle units) have inherent low emissions if operated to do so. However, none of the above have the combined advantages of magnetohydrohynamics' very high energy conversion efficiency with an operating mode that controls NO_x and SO_x emissions typically below EPA New Source Performance Standards (NSPS) -- while using available technology to control particulate emission.

Coal-fired, open-cycle magnetohydrodynamics (MHD) combusts coal at a high temperature, fuel-rich condition, with a potassium salt seed to produce an electrical conducting gas that is passed through a magnetic field to generate electrical power. The still-hot combustion gas is then used to generate steam for a steam turbine to produce additional electrical power. This combined-cycle plant has the potential for an overall plant efficiency of over 50 percent. The potassium in the seed material combines with any sulfur in the coal to form potassium sulfate that is collected in the downstream part of the plant and recycled for reuse as seed material. Experiments have proven that at a molar ratio of potassium to sulfur equaling 1.3 (K_2/S = 1.3), over 90 percent of the SO_2 would be removed from the combustion gases when burning an eastern coal with four percent sulfur. Thus the NSPS standard is more than satisfied when the MHD combustor is operating at its nominal design condition. Additionally, experiments have shown that typical MHD operation at its fuel-rich condition, coupled with a properly designed downstream boiler will over satisify the NSPS requirements for NO_x emission by as much as 50 percent. The particulate produced in the MHD plant tends to be smaller than that produced in a conventional coal-fired power plant. However, MHD particulate resistivity is low (10^6 to 10^{10} ohm cm) compared to most fly ash, thus lending itself to economical electrostatic precipitator collection. Baghouse particulate collection cannot be excluded, but pressure drop versus flowrate is a concern; testing of the baghouse concept will occur in the summer of 1984. 50 percent more efficient coal combustion will provide additional positive environmental aspects because less coolant water, transportation fuel, and mining/reclamation will be required and the total amount of effluents will be reduced.

MHD, a direct burning, high efficiency, coal technology that is inherently environmentally acceptable, is the answer; a statement no other existing advanced direct or indirect burning coal technology can make without penalizing their efficiency or cost.

MHD COMPARISON

One assumption is made, i.e., the data taken to date at the Coal-Fired Flow Facility (CFFF) is well founded - therefore, NO_x, SO_x, and particulate can inherently be controlled by the MHD process to typically below EPA New Source Performance Standards (NSPS).[1] Thus, given the environmental acceptability of MHD, a comparison of recent articles on other environmentally acceptable technologies was made. The results are listed in the Table below and the references are attached (almost all 1984).

		CAPITAL ($/KW)	OVERALL PLANT EFFICIENCY (%)	PLANT SIZE (MW_e)
1.	PC W/FGD[2]	$995/KW	33.6%	Twin 500 MW_e
2.	AFBC (Mature)[2]	820	34.7	Twin 500
3.	PFBC (Mature)[2]	875	39.1	Twin 650
4.	Cool Water (Coal[3] Gasification Combine Cycle - CGCC)	2,500	30.5/32.2	92/101
	Mature CGCC[3]	850-895	39	Undefined
5.	PFBC (Mature,[4] Steam Cooled)	1,130	39.2	529
6.	MHD (Mature)[5]	913	43.9	990
7.	MHD (1st Generation)[6]	1,793	38.0	202
8.	Coal Gasification-[7] Fuel Cell (1st Generation)	1,616	30.7 (35.5% if credit is taken for sale of coalfines & tar/oil products)	150

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Montana leads MHD commercial proposal

By John McNay
Standard Staff Writer

Three Montana companies headquartered in Butte are among a 10-firm consortium which has pledged to carry out a $412.8-million commercial demonstration of magneto-hydrodynamics technology at a gas-fired electrical plant in Billings.

A Montana Power Co. spokesman told The Montana Standard Saturday that the project hinges on a proposal to the Department of Energy for the consortium to put up half the funds to show the technical and economic feasibility of MHD power plants.

The proposal, which would make Montana the focal point for the project, was submitted by Joe McElwain, retired Montana Power Co. chairman and leader of the consortium, to the House Subcommittee on Energy Development and Applications.

but it must have a partner, a reliable partner — the government," McElwain said in the proposal.

The consortiuma will be known as MHD Development Corp. Representing Montana in MHD Development are the Montana Power Co., Mountain States Energy, Inc., and the Montana Energy Research and Development Institute (MERDI), all of Butte.

Other charter members of the consortium are AVCO, Babcock and Wilcox, Inc., General Dynamics Corp., Gilbert-Commonwealth, TRW Inc., and Westinghouse Electric Co.

The consortium is a "strong team," said MPC senior engineering specialist Fred Walter. "They are some big people and they are serious" but participation by the government is essential, Walter said.

The AVCO Research Laboratory MHD research for many years, Walter said. AVCO built the MHD channel that is being used at the Butte test facility, he added. Babcock and Wilcox is a longtime supplier to the utility industry and specializes in boilers that are used in coal-fired generating plants.

General Dynamics builds the type of super conducting magnets that are used in the MHD process and Westinghouse, another major utility supplier, built the inverter that changes the DC current from the MHD facility to AC so that it can go onto the Montana Power grid, Walter said. TRW is a research firm that has built the coal-fired combustor for the test facility at Butte and Gilbert-Commonwealth is a large, architectural engineering firm.

The consortium's plan depends on sustained, five-year research funding of about $40 million annually by DOE and an MHD coal generation

"The impact of burning coal 50 percent more efficiently has tremendous benefits in addition to fuel savings by reducing related environmental impacts through less mining, less transportation, and less effluent," McElwain said.

Walter said the efficiency savings from two full size MHD commercial plants could pay back all the money spend on research to this point.

Walter said it is expected the DOE will receive 160-180 applications for the $750 million in clean coal research money, but he maintained that MHD has more potential than other coal technologies.

Bill Bermingham, industrial relations manager for Mountain States Energy, said his firm is encouraged by the support shown for the MHD process by the consortium and other private industry. MSE contracts with the Department of Energy to operate the Component Development Integration Facility where the MHD process is tested at the Butte Industrial Park.

"We need to have this demonstration project as the next step," Bermingham said. He called Montana Power the "catalyst" in the demonstration project proposal.

The MHD facility successfully ran a newly-developed coal-fired combustor for the first time in September. Prior to that, an oil-fired combustor had been used to simulate the real thing.

The coal-fired combustor, developed by TRW, was the culmination of a $6 million research and development program funded by the Department of Energy since about 1976. Mountain States Energy spent about $523,000 locally in plant modifications to install the unit.

The test facility represents about a $40 million investment and currently employs about 150 people.

The MHD process, mainly being developed in Butte and the University of Tennessee, involves burning coal in the combustor and directing a 5,000-degree stream of gas, seeded with potassium, through a magnetic field at supersonic speed which produces electricity that is tapped by a series of electrodes.

The still-hot gases, about 3,500 degrees, emerge from the magnetic channel and are cooled in a boiler system that produces steam to operate a conventional steam turbine engine.

The Soviet Union is a bit more advanced than the United States in MHD research and already has an operating gas-fired plant.

But when Soviet trade representatives Albert Mednikov and Kirill Ivanov toured Butte's test facility in February they were impressed by its size and technology.

oil or gas-fired Frank E. Bird plant at Billings. The retrofit would boost the plant's capacity from 69 to 88 megawatts. Of that total, 36 megawatts would come from the MHD channel.

If federal funding is approved, construction at the Bird plant would begin in 1988 and the demonstration project would be in operation by 1992.

Walter said MHD use could greatly expand the market for coal because it would make coal-fired plants more attractive. That could mean a big boost for Montana's coal economy.

Among the MHD technology's benefits, McElwain said, are an environmentally clean process that is 50 percent more efficient in producing electricity than traditional coal-fired plants.

-The Montana Standard, Butte, Sunday, April 21, 1985

Senator WARNER. Now, Secretary Vaughan, we are anxious to hear from you. I would say on your behalf personally that we have known each other for some several years, we have worked on a number of issues with the Department of Energy, and I happen to believe that philosophically in your heart, you are of the opinion that the Federal Government should be involved in this research, that we will have to take into consideration that your testimony might not track exactly with the beats of your heart.

And we credit you for what you have done in the past, and I think you will be an effective working partner on this issue in the future.

STATEMENT OF HON. WILLIAM A. VAUGHAN, ASSISTANT SECRETARY FOR FOSSIL ENERGY, DEPARTMENT OF ENERGY; ACCOMPANIED BY DICK HARRINGTON, DEPUTY ASSISTANT SECRETARY FOR COAL UTILIZATION, ADVANCED CONVERSIONS AND GASIFICATION

Mr. VAUGHAN. Good afternoon, Mr. Chairman, members of the committee.

Senator WARNER. Now, you had better pull that mike up tightly because a lot of people are quite interested in what you have to say.

Mr. VAUGHAN. Recognizing that you have several witnesses to follow this afternoon, I would like to submit my formal statement for the record and briefly summarize some of the key points of that statement.

Senator WARNER. Without objection.

Mr. VAUGHAN. I would also like to discuss them, Mr. Chairman, in reverse order of the way they happen to appear in my formal statement.

However, before I begin, I would like to introduce my colleague on my left, your right, Mr. Dick Harrington, who is the Deputy Assistant Secretary involved with coal R&D. I have other staff members with me this afternoon in the event that the committee has detailed questions, so that we can be responsive.

First of all, Mr. Chairman, I would like to stress that what I believe has been the significant positive benefits that have resulted from this clean coal effort. There are, outlined in the final page of my formal statement are these positive benefits. But I would like to use them here at the beginning to emphasize the fact that we believe valuable and beneficial results have already occurred from this effort.

First, the clean coal report we submitted to Congress last week represents a snapshot of industry's interests in new coal technologies. It has told us that industry is prepared to move forward with new concepts that offer significant environmental and economic advantages. While most of the submissions did indicate a need or desire to receive Federal funds, there are several projects that will likely move forward on their own with little if any Federal incentives.

For many energy companies, the exercise served as an organizing point to bring Energy manufacturers, architect engineers and other related firms into project teams. Should some of the proposed

projects proceed, many will incorporate a much wider diversity of research, manufacturing and marketing interests than might otherwise have been the case in the absence of this effort.

The exchange of information between the private sector and the Government has also been a specially valuable product of this effort. We now have a better indication of the direction the coal industry would like to take in the development and application of new technology.

Finally, severally interesting ideas emerged from the exercise that may be of value to future planning of the Government's coal R&D program. As we plan our fiscal year 1987 and future programs, we will have the benefit of some of the new ideas expressed in several of these submissions.

Mr. Chairman, the report we have prepared represents the Department's and administration's commitment to be fully responsive to the Congress. We devoted some 12,000 staff hours within fossil energy alone to the preparation of this report. More than 50 professional staff members from our headquarters, Morgantown, and Pittsburgh energy technology centers participated in this effort. We extended the due date for submissions in agreement with the Congress, and then what I consider to be a significant step further, we took another step in accepting late arriving submissions and incorporating them as much as possible into that final report.

We take a special measure of pride in appendix C of the report, the technology assessments. Here is where we have tried to capture the key features of the technologies proposed and to profile them with—in terms of their economic, environmental and technological potential.

In short, Mr. Chairman, we have completed a report which we believe fully complies with the congressional directive contained in Public Law 98-473.

Now, having completed the required actions, Secretary Herrington has asked us to go yet another step further. As described on page 3 of my formal statement, we will attempt in a supplemental effort to provide fuller characterization of clean coal technologies. To do this, we will draw from this May 1 report, the recent report of the Energy Research Advisory Board, the International Energy Agency's clean coal technology report and other general background material.

We hope to characterize various coal technologies against a set of criteria such as environmental promise, cost, stage of development, and scientific feasibility, to name a few. This additional information will be compiled into a final report and submitted to the Congress.

While we continue to recommend to the Congress that the Federal Government refrain from becoming a financial partner in large demonstration scale projects, we believe such an effort—that is, the preparation of this additional report—will be helpful to the Department, the Congress, and the coal industry in determining the most productive approaches for development of clean coal technology.

In summary, Mr. Chairman, we are in wholehearted agreement with the objective of increasing the use of American coal in an environmentally acceptable manner. We believe that the Government has a legitimate research role to improve coal technologies. The ad-

ministration's research program has been designed to bring about a more economical, cleaner technology for coal that will benefit the domestic coal market as well as the environment and our national economy.

This concludes my opening remarks, Mr. Chairman. I would be pleased at this time to answer any questions of the committee.

[The prepared statement of Mr. Vaughan follows:]

Statement of William A. Vaughan, Assistant Secretary for Fossil Energy, U.S. Department of Energy

Mr. Chairman and Members of the Committee:

Seven months ago, as part of its Continuing Appropriations resolution, the Congress directed the Department of Energy to solicit indications of the private sector's interest in emerging clean coal technologies.

On May 1, 1985, following the evaluation of 175 responses, the Department of Energy delivered to the Congress a 271-page report in response to the Congressional directive. The report represents the product of more than 12,000 cumulative hours of professional staff involvement within the Office of Fossil Energy -- the largest single effort to produce a Congressional report ever undertaken by this office. The report has received the personal attention of Energy Secretary John S. Herrington and reflects both the Secretary's and the Administration's commitment to be fully responsive to Congress in this matter.

We are pleased to appear before the Committee this morning to summarize that report.*

BACKGROUND -- ANALYSIS PROCEDURES

Following enactment of Section 321 of Public Law 98-473, the Department published a Program Announcement in the Federal Register on November 27, 1984, requesting information on emerging clean coal technologies. Simultaneously the Department issued a press announcement describing this effort to more than 250 general, trade, and broadcast media outlets. On December 7, 1984, an insert was also placed in the Commerce Business Daily which called attention to the Department's interest in receiving clean coal technology information.

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* NOTE: Several submitters identified part or all of their submissions as confidential and proprietary business information. To protect the submitters' material and to provide a complete report to Congress, all the confidential and/or proprietary submissions have been included in a supplemental volume that has been made available to the Congress.

Together, these actions were intended to maximize public awareness of the Department's clean coal technology announcement. By the February 15, 1985 deadline (which had been extended from January 18, 1985, in response to a request of the Congress), 167 statements of interest and informational proposals had been received from industry.

Once the deadline had passed for receipt of responses, it became evident that several submissions were still being prepared and would continue to arrive at the Department at later dates. To ensure that the Department's report to Congress was as complete as possible, I directed the Fossil Energy staff to incorporate the late responses into the report if this could be done without jeopardizing the preparation schedule.

In total, therefore, the Department had received 175 submissions at the time the report to Congress was prepared. A subsequent submission was received too late to be analyzed but is included in the summary portion of the report.

While many of the logging and tracking procedures were similar to a formal procurement evaluation, the Department could not adhere rigidly to competitive procurement guidelines. Since the Department neither requested nor was appropriated funds for any of the proposed activities, we made it clear to the submitters that they could not be reimbursed for any expenses they might incur in responding to the Department's announcement.

A senior staff team, made up of Fossil Energy Office Directors, was formed to sort the submissions upon receipt, assign them to the appropriate analysis team and provide specific instructions and guidance. Three separate analyses teams were formed, each led by a member of the Senior Executive Service.

These teams mirrored the major coal-related technical office subdivisions within the Office of Fossil Energy:

Coal Utilization Systems
Surface Coal Gasification Systems and
Advanced Conversion Systems
Underground Coal Gasification and Coal Liquids.

For each team, technical and analytical skills were drawn from Fossil Energy personnel at Headquarters and the Morgantown and Pittsburgh Energy Technology Centers. The Offices of General Counsel and Procurement Support participated on a consulting basis. No personnel outside the employ of the Department participated in or had access to the review process in any way.

Having completed the required actions under Section 321 of P.L. 98-473, we would now like to explain our next steps in the clean coal area and the approach the Secretary has asked us to undertake. Our general approach will be to provide fuller characterizations of clean coal technologies using such information as the Section 321 submissions, information gained from our ongoing budget activities, the recent clean coal report by the Energy Research Advisory Board, and other general background material .

Specifically, the first effort will be to establish criteria against which the technologies could be evaluated. These criteria will include such things as environmental promise, cost, stage of development and scientific feasibility to name a few. Second, the technologies will then each be evaluated against the criteria. The pros and cons for each of these technologies will then be explained.

All of this additional information will be compiled into a final report and submitted to the Congress.

I believe that such an effort will be helpful to the Department, the Congress, and the coal industry in determining the most productive approaches for development of clean coal technology.

SUMMARY OF RESPONSES

As indicated earlier, 175 responses were received, with project values totalling in excess of $8 billion. Sixteen of the submissions did not propose specific projects but instead provided general information or support for individual projects or groups of projects, or endorsed the program in general.

Responses were received for every Fossil Energy coal technology program except one, waste management. Organizations in 28 states and the District of Columbia submitted statements of interest or informational proposals.

One hundred and five of the submissions identified specific locations for their proposed projects. The sites were located in 29 states.

The following table summarizes the submissions received by category of technology:

Technology	Number of Submissions
Flue Gas Cleanup[1/]	31
Fluidized Bed Combustion[2/]	27
Surface Coal Gasification	27
Coal Preparation	22
Heat Engines[2/]	13
Advanced Combustion	10
Alternative Fuels	8
Fuel Cells	8
Coal Liquefaction	5
Underground Coal Gasification	4
Gas Stream Cleanup	2
Magnetohydrodynamics	2
Non-Technology Specific	16
	175

1/ One submitter proposed two projects, so that the total number of proposed projects is 32.

2/ One proposal was evaluated in two categories (Fluidized Bed Combustion and Heat Engines) because it contained technology development in both areas.

Flue Gas Cleanup

Of the 32 projects described in this category, 14 concentrated on in-boiler sulfur dioxide control using sorbents. Seven submissions were received on dry waste flue gas desulfurization processes. Five submissions described regenerable flue gas desulfurization processes and the remaining six represented a variety of miscellaneous approaches.

Most of the submissions were targeted at the large utility boiler market (the one exception was a coal-fired cogeneration process for the pulp and paper industry).

The requested federal incentives, with one exception, were for direct funding. The one exception asked instead for an innovative technology waiver of sulfur dioxide New Source Performance Standards for two new 572 MWe plants in return for installing the limestone injection multistage burner technology.

In two of the submissions, work has already been performed or likely will be completed regardless of federal funding. For 13 of the proposed projects that are similar to existing privately-funded ones, an argument was made for multiple demonstrations in order to provide greater confidence. Lastly, several submitters stated that their projects would not be initiated at all in the absence of federal support.

Advanced Combustors

Ten submissions were for projects that addressed advanced combustor technology. These submissions varied significantly in cost, duration, size and type of coal to be used; however, the projects could be grouped into two general categories: three submissions proposed relatively mature slagging combustor designs for utility retrofits, while seven projects would use less mature concepts that require further development before they would be ready for demonstration.

Proposed federal assistance was in the form of direct cost-sharing. Where justification for federal support was provided, it entailed the unavailability of private funds and the need to minimize risks for the first users of the technology.

Fluidized Bed Combustion

In the Atmospheric Fluidized Bed Combustion (AFBC) area, 21 responses were received (one was received too late for analysis and is included only in the summary section of the report).

Ten projects were targeted at utility applications at scales of 20 Mwe to 235 Mwe. Four would apply the circulating AFBC concept, three would use the bubbling bed AFBC concept, and three indicated that a decision between the two concepts had not yet been made.

Four projects were proposed at the industrial scale, i.e., 200,000 to 500,000 lb/hr of steam production. Three would apply the circulating bed technology to generate steam or for cogeneration, while one proposed the bubbling AFBC concept.

Six statements of interest were received for projects that did not fit in either the utility or industrial categories or were for research and development efforts. One additional project was designated as proprietary information by the submitter.

Many of the AFBC submissions did not provide justification for the federal incentives proposed, but those that did offered the following rationale for government funding support: (1) the hurdle of the significant capital cost differentials between atmospheric fluidized bed combustors and proven alternative technologies, (2) the need to offset partners' financial commitments and not as a condition to complete the project, and (3) in the case of immature technologies, to pay for the risks involved.

Six submissions were received in the Pressurized Fluidized Bed Combustion (PFBC) Technology area. Three were for steam-cooled combined cycle and turbocharged boiler systems, two were for advanced circulating fluidized bed PFBC technology, and one was to operate a federally-funded air-cooled circulating bed pilot plant which is currently being dismantled (the 13 MWe Wood Ridge, NJ, PFB pilot plant).

The submissions describing steam-cooled combined cycle projects stated that federal incentives would help offset the technology risk and initial high costs of repowering or retrofitting existing utility boilers. The project proponents state that demonstration of PFB technology under actual utility operating conditions and scale is essential to determine its performance and economics.

The three proposers suggesting circulating PFBC combined cycle concepts each identified further research that would be conducted at units considered to be at the pre-demonstration plant scale. This research would be necessary before scale up could occur.

Coal Preparation

Although 22 submissions were received in the category of Coal Preparation, only seven proposed demonstration projects. The remaining 15 were for technologies at scales less than demonstration.

Three of the demonstration projects were labeled as proprietary. The others proposed to clean coal with (1) microbubble column flotation followed by high speed centrifuge dewatering; (2) physical cleaning techniques, followed by hot water drying, and acid extraction; (3) high gradient magnetic separation; and (4) a combination of physical and microbial cleaning techniques.

The federal incentives requested were almost exclusively direct funding and were deemed necessary by the submitters (1) because internal funds were not available to support a demonstration project; and (2) to make the technology available to the industry by the late 1980s.

Alternative Fuels

Eight submissions were received in the alternative fuels category, and all involved the application of coal-water mixture technology. Two of the submissions were identified as "Confidential Proprietary Information" by the submitters, and one did not propose a specific project.

The remaining five projects proposed (1) the development of a slurry fuel by applying the oil agglomeration beneficiation technique, (2) the use of a model to study and maximize the efficient use of coal in a blast furnace, (3) the development of a coal-water-mixture/natural gas co-firing fuel with a sulfur absorption additive, (4) the development of a coal-water mixture fuel containing sulfur captor compounds, and (5) the assessment, retrofit and operation of a gas-fired utility boiler using a coal-water mixture fuel.

Six of the eight projects proposed in this category have been initiated in some form. One has developed to the point where the next step is commercial demonstration; the others range from bench scale to proof-of-concept projects. All projects, with the exception of one, were applicable to the industrial sector. The one exception entailed a retrofit to a utility gas-fired boiler.

None of the submitters, with the exception of one proprietary proposal, directly addressed justification for federal incentives. Where the type of incentive was described, it was either a direct financial award or an award in combination with a federal loan.

Gas Stream Cleanup

Two gas stream cleanup projects were submitted. One of the submissions proposed a method for inbed desulfurization within a coal gasifier using mixed metal oxide sorbents. Federal financing, involving direct funding, was requested for the entire development process, from basic research through pilot demonstration.

The second project cannot be discussed or described since the submitter declared the entire proposal to be proprietary.

Surface Coal Gasification

Surface coal gasification was the core technology in 27 submissions. The projects were subsequently divided into three groups -- utility systems, industrial/residential systems, and special applications -- based on the major application of the technology.

Utility Systems -- The 11 submissions that would apply to the utility sector ranged from the development of a thermodynamic model for coal gasification to the commercial demonstration of integrated gasification combined cycle systems at scales of 5 to 400 MWe.

Many of the integrated gasification combined cycle projects specified technology similar to that currently being demonstrated at the Cool Water project in California. One project, however, proposed the eventual replacement of conventional combined cycle technology with advanced gas turbines. Gasifiers included slagging fixed bed systems, fluid bed systems, and entrained flow systems. Gas cleanup systems ranged from conventional cyclones and wet scrubbers to one advanced in-bed desulfurization and hot particulate removal system.

All of the submissions sought direct federal funding support for capital costs and in some cases operating costs. Two principal reasons for this assistance were cited: (1) the significant risks entailed in recovering project costs in later years due to the heavy dependence on projected fuel price differentials; and (2) the substantial cost of gasification/combined cycle equipment which cannot be financed by the usual private utility means due to its novelty and the lack of evidence that the technology is practical and economical.

Industrial/Residential Systems -- Nine submissions were received for either the demonstration of gasifiers applied to small to intermediate size industrial/residential applications, or for coal-based concepts for producing chemicals and synthetic natural gas. Proposed projects ranged from a small (3.75 ton per day) pilot plant to a near commercial size (1648 ton per day) advanced gasification system. Federal incentives were advocated by the submitters due principally to the lower level of technical maturity and higher degree of risk associated with the gasifiers in this group.

Special Applications -- Seven projects proposed in this category could be further divided into two more specific categories:

(1) five proposed projects to convert coal to coproducts in addition to, or as a preparatory step to, the production of synthetic gas. Such coproducts include metallurgical grade coke as well as product chars with significantly better properties (lower sulfur and ash and higher heating value) than the original coal. Facilities in this category ranged in size from small laboratory research units to a 1000-ton per day demonstration plant. One project in this category requested a price guarantee and loan guarantee, while the others asked for direct federal funding.

(2) two submissions proposed advanced iron-making techniques that would use coal gasification technology as part of the process. According to the submitters, direct federal funding would be required for the projects, each of which would produce 300,000 tons per year of high purity iron for steelmaking.

Fuel Cells

Eight submissions were placed in the fuel cells category, seven of which proposed the use of the phosphoric acid technology (the other suggested an advanced molten carbonate concept).

Three submissions proposed to link a fuel cell with existing gasifiers at either the Cool Water, Tennessee Valley Authority, or Twin Cities

projects, although none of the submissions showed a way in which true integration could be accomplished with an existing gasifier. Two submissions proposed a grass-roots design. Five of the submissions would rely on conventional gas cleanup techniques, one left the gas cleanup and system integration issues to be determined, and one did not address gas cleanup at all. All but one of the projects would be applied to utility power generation; the one exception would produce dc power for a chlorine/sodium hydroxide plant. All included direct federal funding, and in addition several proposed the use of government facilities and price guarantees for the product energy.

Heat Engines

While several submissions were received that included heat engine technology as part of the overall energy system, 13 submissions could be categorized as specifically focusing on the heat engine hardware.

Seven submissions would substitute coal fuels for distillate fuels in locomotive propulsion. Concepts included dry powdered coal or coal-slurry fueled gas turbines (two), a coal-derived gas-fueled turbine or diesel, a hybrid steam-diesel concept, an advanced fluid bed combustor/boiler combined with a steam turbine-electric drive, and an advanced fluidized bed boiler to drive a steam reciprocating cycle. One of the coal-slurry fuel-gas turbine proposals also included a slurry fuels diesel engine as an option.

Three submissions were assigned to the category of industrial cogeneration, i.e. they would generate both process heat and electricity simultaneously. One would employ a coal-fired gas turbine, one a coal-fired fluid bed combustor, and one an air-blown gasifier, hot gas cleanup system, a diesel engine and a heat recovery boiler.

Three submissions were assigned to the Combined Cycle Power Generation Systems subcategory. All involve gas turbine component development for subsequent integration with coal gasifiers. One of the submissions was essentially a research and development effort. The other two proposed modifications to enhance efficiency and improved environmental performance.

Federal support was requested primarily in the form of direct funding although in one case a loan guarantee was proposed. Federal subsidies were judged to be necessary by those submitters assigned to the Locomotive Propulsion Systems subcategory because both railroad operators and locomotive manufacturers are reluctant to begin expensive research and development projects without reasonable expectations of commensurate payback in the near term. Federal support, according to the submitters, could result in initial testing of coal-fired locomotives within 3-1/2 to six years from the start of development, as compared to the end of the century if there was no federal involvement.

The submitters' justification for federal incentives in both the Cogeneration Systems and Combined Cycle Power Generation Systems were based generally on the relatively high initial development costs compared to long-term payback uncertainties.

Magnetohydrodynamics

Two submissions were received for retrofits of the magnetohydrodynamics (MHD) technology to the existing Montana Power Company's Bird plant. Both proposed projects would be contingent upon continuation of proof-of-concept testing by the Department of Energy, and both include the Bird plant as part of the private sector's cost sharing (although the estimated value of the plant varies by more than 100 percent depending upon the submission). The addition of the MHD topping cycle to the existing facility would increase its power output from 66 MWe to 88.6 MWe.

The federal incentive requested was direct funding at levels of about 50 percent when the submitter is given credit for the candidate base power plant and assuming that continued federal support is provided for the ongoing MHD program. This amounts to a 75 to 80 percent federal share of the direct out-of-pocket expenses. The submitters cited the high-risk, long-range nature of the MHD advanced power development effort.

Coal Liquefaction

Five submissions were received in this category. Two described exploratory bench scale research efforts. One was an informational letter documenting the submitter's ongoing interest in coal liquefaction and encouraging the Department to recognize out-year needs for pilot plant testing of new concepts. Two submissions addressed the co-production of electric power and methanol from coal using the Tennessee Valley Authority's Coal-to-Ammonia facility at Muscle Shoals, Alabama.

Direct federal funding was the preferred government incentive with cost-sharing described in only one of the submissions, the TVA-proposed "once-through" methanol synthesis project at Muscle Shoals. Federal involvement was necessary, according to the submission, to reduce uncertainties associated with the scale up to commercial size, construction and operating costs, and market potential for the methanol synthesis technology.

Underground Coal Gasification

Four submissions involved underground coal gasification. Each represented a totally separate technology or concept. One was a letter of interest from a firm proposing to undertake several risk reduction research studies. One submission suggested government funding for a research and development program to use unmineable coal as a sacrificial energy source to retort oil shale in place. A third proposal was for a cost-shared commercial plant to produce synthetic gas for a Wyoming power plant. The fourth proposed project was for a pilot and demonstration effort of underground gasification in a steeply dipping anthracite seam in Pennsylvania.

Where included, the justification for federal involvement was generally to reduce risks to sufficient levels to attract private capital.

THE ISSUE OF FEDERAL INCENTIVES
TO ACCELERATE COMMERCIAL AVAILABILITY

The Congress also requested the Department, through Section 321, to identify the extent to which federal incentives might accelerate the commercial availability of emerging clean coal technologies. After analyzing the submissions, the Department concluded that federal incentives will not accelerate commercialization of these technologies and may, in fact, be counterproductive to their development.

The majority of submissions expressed a need for federal financial assistance, mostly in the form of direct funding. However, several of the emerging technical options addressed in the submissions are currently being developed at near-commercial or commercial scale without federal funds.

It should also be noted that cost sharing offered by the proposers varied significantly, not only in terms of the total amount but also in the nature of the cost sharing. For example, some proposers offered the amount of previous expenditures as "cost sharing" in return for 100 percent federal financing of future costs. Others offered to share all future costs. In many cases, cost sharing statements were not provided or were incomplete.

It should also be expected that several firms would opt for federal funds, if they were available, and some of these firms could conceivably delay the implementation of privately-financed development efforts while waiting for federal financing to materialize. The possibility also exists that some proposers who might have proceeded on their own would wait until they see which technology is backed by the government, then decide if they can effectively compete against a federally subsidized effort.

Some technologies that may not appear to be advancing rapidly to commercial scale may be hindered by valid technological or economic reasons, and therefore, may require additional research and development before they are commercially viable.

Other technologies may simply never be competitive, and the inability of these technologies to attract sufficient private sector investment may reflect investors' sound judgments as to their ultimate potential. Federal financing in these cases would not be productive regardless of the amount.

In some cases, the pace of commercial development and deployment may not hinge as much on technological issues as on the uncertainty of market demand or the uncertainty of future emission regulations that could spur demand for clean coal technologies.

Given the size and availability of U.S. coal reserves, the security of the domestic coal supply, and the comparative economics of coal as a fuel, free market forces are operating to select and commercialize the most efficient and environmentally-effective clean coal technologies. Federal subsidies could alter these market forces and adversely affect the development of competing technologies both within and outside the coal industry.

These conclusions are based on the Department's previous experiences with federal incentives. Commercial or near-commercial scale projects selected to receive assistance under prior incentive programs have been largely unsuccessful in commercializing new fossil technologies. Moreover, their lack of success has, in all probability, compounded the problems associated with the introduction of new technology. It is quite likely that related private sector projects have not been initiated because of the perceived competitive disadvantage of competing against a federally subsidized effort.

We are in wholehearted agreement with the objective of increasing the use of American coal in an environmentally acceptable manner. We believe that the government has a legitimate research role to improve coal technologies. The Administration's research program has been designed to bring about a more economical, cleaner technology for coal that will benefit the domestic coal market as well as the environment and economy in general.

Accordingly, the Department recommends to the Congress that no federal financial incentives be provided for the demonstration and commercial development of emerging clean coal technologies. Rather, the Department should continue to channel its resources into the highly productive areas of more generic coal technology research and development.

BENEFITS OF THE CLEAN COAL SOLICITATION EFFORT

Even though we recommend no future federal funding for the projects described in the submissions, significant value has already resulted from the process of soliciting statements of interest and informational proposals.

For many energy companies, the exercise was used as an organizing point to bring equipment manufacturers, architect-engineers, and other related firms into project teams. Should some of the projects proceed, many will incorporate the expertise of research, manufacturing, consuming and marketing interests within the same project framework, due to the information exchange that took place during this effort.

Information exchange between the private sector and the government was also an especially valuable product of this effort. A better indication now exists of the direction the coal and coal-related industries would like to take in the development and application of new technology. In addition, several interesting ideas emerged that may be of value to future planning of the government's coal research and development program.

This concludes my formal testimony, Mr. Chairman. I will be pleased to answer any questions you or Members of the Subcommittee may have.

Senator WARNER. Thank you.

On page 6 of your abbreviated statement, the sentence reads: "This additional information will be compiled into a final report and submitted to Congress." My question is, Can you give us a date in view of the fact that the appropriations cycle is likely to go forward?

Mr. VAUGHAN. I believe, Mr. Chairman, that it will take several months to do such an effort. I believe that we will first have to select an appropriate format for having this study conducted. It is my personal opinion that that format should be outside and independent of the Department, and I intend to make that recommendation to the Secretary. And we will have to fashion the appropriate funding vehicle for such work, and then we will have to allow adequate time for the work.

I do believe it will take a matter of months. Otherwise I believe such a report would be technologically superficial.

Senator WARNER. Then it is not likely it will be available for the Congress in this particular legislative cycle, between now and the fall?

Mr. VAUGHAN. I would not think so, Senator, no, sir.

Senator WARNER. All right. Now, I assume the Congress will go ahead and begin to appropriate moneys for clean coal technology on its own initiative. Now, are you able in the interim to give us any advice on how to prioritize, evaluate, or assess the several projects?

Mr. VAUGHAN. We do not believe we are in a position, Mr. Chairman, to prioritize or rank the specific proposals that we received. And the reason for that is that those proposals range widely in the degree and nature of their technological quality.

That is because there was no funding available at the time the effort was commenced, so that these submissions were not anywhere near the quality one would expect to receive if one ran a full competitive process. And we would strongly urge that if the Congress moves forward in this area that it should empower us to run full competitive procurements.

Senator WARNER. Turning to another section of your report, you recommend, or one of the reasons on which you predicate your recommendation of no Federal incentives, I want to quote:

> Projects selected to receive assistance under programs providing such incentives as direct funding, cost-sharing, cooperative agreements, price and loan guarantees, have, with few if any exceptions, been unsuccessful in commercializing new fossil fuel technologies.

Would you provide this committee with examples of such projects?

Mr. VAUGHAN. Yes, Mr. Chairman, I will be more than happy to provide a list of projects in the past that the Department and its predecessors have funded in a demonstration mode with massive quantities of money, such projects producing no commercial activity.

[The information referred to follows:]

DOE SPONSORED DEMONSTRATION PROJECTS

The Department of Energy (and its predecessor ERDA) has funded numerous demonstration projects during the period when our national policy goal was energy independence. Since that time, the national policy goal has evolved to achieving an adequate and balanced supply of energy at a reasonable price in the marketplace. In response to this change, Fossil Energy's R&D was redirected to long range, high risk programs with high payoff potential while the Synthetic Fuels Corporation provides financial assistance opportunities for first of a kind pioneering facilities. Thus consistent with DOE's new role, Fossil Energy's demonstration programs were formally terminated in January 1981, and all activities associated with the demonstration plants have been concerned with contract closeout.

The following lists represent those demonstration scale projects Fossil Energy has sponsored distinguished by whether or not industry has further developed the project technology to the commercialization stage. This stage is defined as that point where the demonstrated technology has been further developed by industry through the construction and operation of a commercial-scale facility. This criteria excludes any reference to the marketplace viability of the commercial product.

Many of these demonstration projects were terminated as a result of the aforementioned policy goal shift at varying stages of incompletion. It should be realized that some projects currently are licensed and available for commercialization pending appropriate market conditions. However, industry has not taken these available technologies to the commercialization stage as of the present time.

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant and Demonstration Projects
Not Commercialized as of May 1985

Project Title	Facility Type
Solvent Refined Coal (SRC-I)	Liquefaction Demonstration Plant
Solvent Refined Coal (SRC-II)	Liquefaction Demonstration Plant
Conoco High-Btu Pipeline Gas	Gasification Demonstration Plant
Illinois Coal Gasification Group High-Btu Pipeline Gas	Gasification Demonstration Plant
Memphis Light, Gas & Water Division Medium-Btu Industrial Fuel Gas	Gasification Demonstration Plant
W.R. Grace Gasoline Plant	Gasification Demonstration Plant

Senator WARNER. And you might also give us a list of those projects, if any, that have been successful.

Mr. VAUGHAN. We would be more than happy to furnish such a list, yes, sir.

[The information follows:]

DOE/FOSSIL ENERGY SPONSORED MAJOR PDU, PILOT PLANT AND DEMONSTRATION PROJECTS

[Successfully commercialized as of May 1985]

Project title, facility type:
Great Plains Coal Gasification Project (GPCGP)—Gasification Plant.[1]
AFB Industrial Applications—Atmospheric Fluidized, Bed Industrial Boilers.[2]

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[1] It should be noted that the Great Plans Project is a commercial venture and although operating, it is not considered financially successful in light of marketplace conditions.

[2] In excess of 100 advanced fluidized bed (AFB) boilers have been commericialized to date.

Senator WARNER. A number of the utility submissions state as a justification for direct Federal support the fact that such costs are not allowed by public utility commissions. Why doesn't the utility investor have an incentive to do this, the R&D, anyway?

Mr. VAUGHAN. I must confess, Mr. Chairman, that I think the utility submissions in this vein have some merit and substance to them. It is true, unfortunately, that our public utility commissions tend not to allow or encourage the companies which they regulate to participate in R&D activities.

I think that is extremely unfortunate public policy, but I do not think that the proper cure for it is to have the Federal Government spend massive amounts of money in demonstration projects.

Senator WARNER. The Chair will try to contain my brief questions to a brief period, to allow my colleagues to ask their questions.

Senator FORD. Does that mean we have to contain ourselves?

Senator WARNER. Whatever you wish about containment.

Senator FORD. Let's get down to a good one, Mr. Vaughan. Let's take it right out of the box. I understand that the press reported that Secretary Harrington—that's the big Secretary—told a House panel that he would agree to rank the projects submitted in response to the clean coal technology solicitation.

But there is some dispute as to whether he meant he would rank the technologies or the projects. Would you be willing to rank either or both?

Mr. VAUGHAN. Senator, I have discussed this matter with the Secretary and I can tell you with a high degree of confidence that he did not mean that he could rank the specific projects, that is each project one through 175 in order of their merit. He did not mean to convey that it was possible for us to do that.

He did mean to indicate that we would try to help the Congress with respect to the subject of prioritizing technologies. However, let me point out to you that that is an extremely difficult task and at best the results will be far from giving you a certainty.

And the reason is, ranked for what and against what? For example, do we want to prioritize with respect for implementation by utilities or the transportation sector or the residential consumption

sector? Shall environmental compliance be the guiding ranking mechanism? Costs status, degree of cost-sharing, et cetera.

So to rank technologies in the abstract will be difficult at best, and the results will still not provide, unfortunately, a clear road map. That simply is the nature of technology. We are dealing with a very complex subject with very wide application in our economy. And while we will—that is the purpose of our offer, in fact our commitment to do an additional report, that we provide further information since Congress has asked for it, but I think I would be less than candid if I indicated that that would produce any sort of clear technological road map. It just doesn't come that way.

Senator FORD. Well, I understand what you are saying. We are getting into an unknown. But with the best ability that you have, would you be willing to build a white elephant?

Mr. VAUGHAN. No, I wouldn't like to build a white elephant.

Senator FORD. I said would you be willing to.

Mr. VAUGHAN. I don't think so, Mr. Chairman, if I understand——

Senator FORD. How do you know whether it's going to be a white elephant or not if you rank it one, two, three, or four based on what you just said?

Mr. VAUGHAN. I believe, Senator, that if we are in a competitive solicitation then we are able to rank. We have a specific goal we have outlined for the solicitation, and then we are able to compare projects against one another submitted in that competitive atmosphere. And there I believe one can make choices.

Senator FORD. Well, then you're saying that you can make a choice based on the competition on the projects versus the technology, the technology as applied by the project. You're saying that in that competition you can make a judgment.

Mr. VAUGHAN. Yes, I can.

Senator FORD. OK. So then when you make that judgment you'll have the project versus technology, and you can rank those one, two, three, four, and submit those to Congress?

Mr. VAUGHAN. If we run a full competitive solicitation, yes, we could rank the projects we receive, and that's what you would do. You would select the best one.

Senator FORD. What is a full competition? Have you not done that already? You have 170 applications, 171 applications. Haven't you run the gamut on that?

Mr. VAUGHAN. No, we have not, Senator, because we received such widely varying quality. And the reason we received widely varying quality is that much of the private sector was well aware of the fact that there were no funds currently appropriated for the project.

And we also felt constrained to inform submitters that it was the administration's position that it did not intend to seek funding for demonstration. I want to make very clear that that is for demonstration purposes and that is not for R&D purposes. It's very clear that we are committed to long-range high-risk generic R&D activities. But we are not persuaded that the wisest use of public funds is in demonstration projects.

At any rate, since funding was not available, we received a very wide range of quality. It is very clear from a number of these sub-

missions that companies were merely getting on the record an interest and did not submit the quality of proposal that they would be, otherwise would be if a full-fledged solicitation were in force.

I would strongly urge that if we are to proceed, regardless of the philosophical differences, that certainly should be a competitive solicitation so that we can get the very best of projects for funding.

Senator FORD. Well, wouldn't you agree that you have a variety of interests?

Mr. VAUGHAN. Yes, sir, a wide variety, an interesting and encouraging array of ideas and concepts.

Senator FORD. So you are encouraged by the applications?

Mr. VAUGHAN. Absolutely, yes.

Senator FORD. Would that change your negative approach to the funding of this money for new coal technologies?

Mr. VAUGHAN. We still believe, Senator, that in the context of the fiscal concerns for this country, that demonstration projects are not the wisest use of funds in this area. We believe that our activities devoted to long-range generic R&D offer a wider array of technological options to the public, when then the public can decide in its entrepreneurial nature to go out and take the risk and fund and demonstrate and commercialize.

We do not believe that that is a proper place, or certainly in these fiscally constrained times the wisest place, for Federal funding.

Senator FORD. It seems like to me we had an agreement on windfall profits tax back there, and we got an agreement that certain moneys would go into certain phases, and one of them was synthetic fuels. And you've been using that money by taking it out and putting it into the general fund, trying to reduce the deficit.

Now, we find recently you tried to take money out of the highway trust fund and put it into firefighting and raising salaries of the Interior Department. We find various and sundry raids into funds that Congress has set aside. Now, we continue to do that, and your approach appears to be that you're doing everything you can to delay any kind of consideration of clean coal technologies, and you keep going to the free enterprise system.

Well, let me ask you this: Can a company whose product prices are regulated take the same degree of risk as companies whose prices are not regulated?

Mr. VAUGHAN. Probably not.

Senator FORD. Probably not, is that it? Is that your answer?

Mr. VAUGHAN. Yes, sir.

Senator FORD. The distinguished chairman wants to interrupt, and I am delighted.

Senator WARNER. If you would yield to me for one question, then I have to absent myself and will return, but you can continue with the hearing.

Listening to your reply, Mr. Ford, prompted this thought. Some of the greatest savings can be made in the transportation industry, namely in the rail system and in the utility generation of heat, power, and so forth. It would seem to me we could write a very simple direction to the Department to go ahead with the competitive RFP for, say, a locomotive to operate on a rail system fueled

by a derivative, or some language in there to tie coal in as a source of fuel, the primary source of fuel.

The question that comes to my mind—and then leave open for the Department to administer the RFP, analyze the technologies, and so forth. But the question is, how much money do we need to put in to back up that RFP? Would you as a Department be willing to have a, call it informal, if you will, discourse, if you will, to give us some guidance on the amount of money you think would be required, and then a comparable system in the utilities?

I mean, it's not difficult to describe, that you want to generate heat, power, light, whatever it may be, from a derivative of coal.

Mr. VAUGHAN. I think, Senator, we can work with you in the vein of the capability statement, where if you ask us, what will you get for a certain amount of money in these areas, certainly in this area or that area, we can answer that question for you. That sort of thing we can help you with.

With respect to such a question as how much money should we spend for locomotives——

Senator WARNER. What about a locomotive, one sound test of a full-scale model? Perhaps two, but let's start with one.

Mr. VAUGHAN. What we could give you there, Senator, would be a summary of what we have received from the private sector, and as I'm sure you are aware we've received a considerable amount of interest in locomotives and the use of coal in locomotives, with frankly an encouragingly wide array of technologies.

These are not limited to simply one approach. There are several approaches involved.

Senator WARNER. The Congress should not try and sort out that?

Mr. VAUGHAN. Now, what I think would be more appropriate, if I understand your question, would be if the Congress desires that we have demonstration activities with respect to coal-fired, coal-use in locomotives, it should decide how much money it wishes to expend in that effort and then direct the Department to conduct a competitive procurement in that area.

And I think out of that the country would endup with the best shot towards that particular goal.

Senator WARNER. Now we're making a little progress, Mr. Secretary.

Thank you, Mr. Ford. If you would just continue in my absence.

Senator Ford [presiding]. I was enjoying your questions.

Well, let's shift gears again, Mr. Vaughan. In reading the testimony of other witnesses today, I came across an interesting statement by Mr. Richard Disbrow. He will testify today on behalf of the Clean Coal Technology Coalition. He says in his prepared statement, and I quote from that statement:

> If new clean coal technologies are to be utilized to meet expected capacity demands during the mid- to late-1990's, those technologies must be commercially demonstrated and available in the 1990 to 1993 timeframe. It takes approximately 3 to 4 years to design and build a commercial demonstration and 2 years to conduct testing. Therefore, to be available in the early 1990's these clean coal technology demonstrations must be initiated in the 1985–88 timeframe.

Do you agree with Mr. Disbrow's statement?

Mr. VAUGHAN. I think he's substantially correct. I find little to nothing of disagreement.

Senator FORD. Are you confident that in the absence of Federal funding the freemarket is going to create these clean coal technology demonstrations in the 1985–88 timeframe?

Mr. VAUGHAN. I think in the absence of Federal funding for demonstrations, Senator, it must be candidly admitted that the pace will be slower. I think there is no question about that and I have no hesitation to make that statement.

But the question is, in our judgment, since we are dealing with limited funding, should we not use it in such a manner as to offer a wider array of technological options and then let the entrepreneurial spirit worry about the pace at which it becomes commercial?

Senator FORD. Well, spirit is one thing. The ability to make the spirit go is another. You know, if we have a lot of faith, we have faith in this program, we have faith in the technician, in the technology, but the Bible says faith without work is dead, and so spirit without money is dead. You know, you just can't get out there and get enough crumbs. Well, it might keep you alive, but you need a whole meal every once in a while so you can run the race.

All you are doing is saying: Here, we're through; we don't have any money. Well, you took about $17 billion and reduced it to $5 billion. What did you do with the other $12 billion, you know, out of synthetic fuels? We fought like the devil to hold $750 million in clean coal technologies.

Let me get to this one other one. If the Administration does find that acid rain precipitation requires the imposition of substantial reductions in SO_2 and NOx emissions, where does the lack of clean coal technologies, the lack of clean coal technologies in place, leave us?

Mr. VAUGHAN. It would leave us possibly with some shortfall, Senator. However, I would point out that the administration has significantly stepped up efforts with respect to acid rain research and development. We definitely believe, however, that we must understand the phenomenon and understand its linkages, cause and effect, before we can adequately deal with the problem as far as coal use.

Meanwhile, we have in our R&D program several activities under way designed to produce technological options for dealing with acid rain.

Senator FORD. Well, I agree with you, we need more time to find out exactly where it comes from and how it occurs. But I think, as we say down in Kentucky, we are going to begin to eat our seed corn, and in eating our seed corn we don't have enough money for this, we don't want to do that, we're going to have to withdraw from this, we're going to stick our head in the sand, you know.

And yet, the future is right on us. It's tomorrow, and we sit here and say we can't do it. But you allow lots of things. I can look at the budget and show you where lots of things have gone up considerably: foreign aid, 158 percent since this administrations been in; and the domestic programs have gone down 65 percent.

And you talk about eating seed corn. You're really doing it. You're promoting jobs overseas and coming back and displacing ours. That's a philosophy I don't like, Mr. Vaughan, and that's a philosophy that you are demonstrating here today. I hope I can somehow change your mind or we in Congress can pass something

that's stringent enough that'll put you in the path of trying to get some of these things done.

Since our colleague is gone, I'm in charge. Since I'm 99 and you're 100. [Laughter.]

I would be delighted to yield to my distinguished friend from West Virginia, whom I'm very fond of.

Senator ROCKEFELLER. Thank you, Mr. Chairman.

Secretary Vaughan, forgive me this. Before you came to the Department of Energy, you worked for which corporation?

Mr. VAUGHAN. General Motors Corp.

Senator ROCKEFELLER. What was your position there?

Mr. VAUGHAN. I was the director of energy management.

Senator ROCKEFELLER. And you came directly from General Motors to the Department of Energy?

Mr. VAUGHAN. That is correct, sir.

Senator ROCKEFELLER. How do you see—why did you come to serve in the U.S. Government in the Department of Energy? What was your motivation in a Department of Energy context?

Mr. VAUGHAN. I came, Senator, to assist the President in his crusade to change the way we govern this country from the Federal level.

Senator ROCKEFELLER. Now, was that with respect to all of the various activities of the Federal Government or did you have a particular motivation with respect to the Department of Energy that allowed you to be enthusiastic about that position at the Secretary level, as opposed to another agency?

Obviously, you've been in energy at General Motors. You went to energy in the Federal Government. There's a carryover. There must have been enthuasiasm, there must have been a purpose. You get paid a great deal less at the Department of Energy than you do at General Motors, I would guess, and therefore there must have been a particular reason for doing that.

Mr. VAUGHAN. Yes, Senator. I felt that much of what had gone on in the Department of Energy in the past was in dire need of changing, and I felt quite enthusiastic about being part of that changing.

Senator ROCKEFELLER. Could you list a couple of those things which were displeasing to you?

Mr. VAUGHAN. Yes. I thought the extensive price and allocation controls dealing with energy shortages actually had caused the shortages in many respects that this country had undergone, and I thought it was in deep need of change. And I am proud to have been associated with changing it.

I thought that we were spending far too much money in specifically demonstration activities that produced basically iron monuments and no commercial activities. I thought that that needed changing.

And I did feel that there is activity that the Federal Government should be involved in, long range high risk generic type research and development in those areas which the private sector is unable or unwilling because of the risk to become involved in, and that that is worthwhile; and that that is on a level of funding that does not mortgage our future, and I could enthusiastically participate in that.

Obviously, there's a longer list, but you asked for some examples.

Senator ROCKEFELLER. I understand.

Now, I would assume that you would agree that it is, if not the role of government, certainly a legitimate role of the Federal Government to try to look at the overall cost of energy policy, its future implications; if there are areas where there is imbalance or error, that those would be corrected; and that the effect on American society as a whole is a legitimate pursuit of a role of the Federal Government.

Mr. VAUGHAN. It would be hard to disagree with that. I certainly subscribe to that, Senator.

Senator ROCKEFELLER. You have been assistant secretary for some time now at DOE.

Can you tell me how much the Energy Department has spent in research money to assure that the nuclear powerplants run safely?

Mr. VAUGHAN. I can't off the top of the head, Senator. We'd have to agree upon over what period of time, and then it is just a matter of getting those figures.

Senator ROCKEFELLER. Would you do that for us?

Mr. VAUGHAN. I'll be more than happy.

[The information follows:]

DOE EXPENDITURES IN SUPPORT OF SAFETY IN NUCLEAR POWERPLANT OPERATIONS

The Department has spent approximately $5.0 million on efforts to directly improve the operations of nuclear power plants. This work has primarily been related to operator training.

There are other areas in which work has been conducted that does not deal directly with operating the plant safely, but does affect overall plant safety and safety to workers. Approximately $11.7 million has been spent on ways to reduce radiation exposures to plant workers and $29.9 million has been spent to date in conducting experiments in the LOFT reactor dealing with postulated accident conditions for power reactors. And finally, there has been another $20 million spread out over a several year period on regulatory related issues. For example, the Department did work to provide the licensing basis for removing one of the items (operation of sump pump following a Design Basis Accident) on the Unresolved Safety Issues list.

In total, the Department has spent approximately $66.6 million since the beginning of this Administration in support of enhancing safety in nuclear power plant operations.

Would you like to, shall we say, since the beginning of this administration as the beginning point?

Senator ROCKEFELLER. That would be good. That would be fine.

Mr. VAUGHAN. OK, sir.

Senator ROCKEFELLER. Can you tell me how much the Nuclear Regulatory Commission spends on nuclear safety each year?

Mr. VAUGHAN. Again, the same sort of answer. I can't off the top of the head, but I am sure I could come by those numbers.

Senator ROCKEFELLER. And will do so.

Mr. VAUGHAN. Will do so.

[The information follows:]

NRC EXPENDITURES

For the last three years NRC has spent in the range of $366 to $430 million to insure that nuclear power plants operate safety.

Senator ROCKEFELLER. The total nuclear research, not nuclear, but nuclear research which is obviously pointed toward the future for fiscal year 1985 was $350 million. The suggestion for fiscal year

1986 is $362 million for the total research budget. Clean coal technology is slated for zero.

When one makes a judgment—and I understand that you didn't write the entire Federal budget, Mr. Secretary. But when you make research judgments of that sort and then you say to nuclear energy—a technology for which there have been no permits requested since, I believe, 1978 or earlier, that is, for nuclear powerplant construction, and for which the market, Wall Street has rejected out of hand, saying there is no market for this, there are no investors for this, there's no future for this, there is nothing in the future that attracts us to this—that DOE is putting in one fiscal year, that being fiscal year 1985 a total of $350 million; is that not in itself a form of market intervention?

Mr. VAUGHAN. Well, Senator, I think the comparison that you are making there is to same degree, respectfully, sir, an apples-oranges comparison. For example——

Senator ROCKEFELLER. It's not apples and oranges to me, Mr. Secretary.

Mr. VAUGHAN. We, it is true, we have not requested funding for this specific form of coal demonstration, coal utilization demonstration. We have, however, requested funding in fossil energy in the tune of some over $300 million for fiscal year 1985. The bulk of those funds are for coal R&D, as in my opinion they properly should be.

Senator ROCKEFELLER. Well, if I may, I would like to, with the permission of the chairman, refresh your memory.

Starting in 1981, $501 million, is that all of research and development or nuclear? That is nuclear, yes, atomic energy general science. Does that describe research?

Mr. VAUGHAN. I believe the bulk of funds spent in the nuclear program, Senator—and keep in mind that I am not personally responsible for this program, so I am not intimately familiar—are essentially R&D activities.

Senator ROCKEFELLER. $501 million in 1981, which I understand is not necessarily under your jurisdiction; over $400 million in 1982, $464 million in 1983, $505 million, $522 million, $546 million, and on it goes.

I just wonder if that is not in effect—I mean, we sat here yesterday, several of us, and listened with substantial interest to General Motors and Ford describing the free market and its sacrosanct nature in American society. I am just kind of wondering if that type of intervention through Federal funds, suggested and admittedly voted by the Congress, but nevertheless suggested by the Department of Energy, or certainly not disapproved by the Department of Energy, why is that not a form of market intervention?

I mean, if I'm going to invent a Tootsie Roll, and it has not been invented, I'm going to do some research, and if I don't have the money to do some research to find out if it has an acceptable taste, I'm going to have to either borrow or get or be appropriated some money to find out if Tootsie Rolls have an acceptable taste for either the country or the world at large. I'm going to have to get it from somewhere.

Now, isn't that a form of market intervention if the Federal Government gives that money to me, or in this case, to nuclear research as opposed to clean coal research?

Mr. VAUGHAN. Oh, I think frankly any activity is some form of market intervention, and I would not like for you, Senator, to have the idea that our reluctance here is purely one of philosophy. We think there are some very practical reasons, in addition to the philosophical ones, for refraining from demonstration activities as opposed to spending those funds in research and development activities.

But I think it has to be admitted that any activity is some form of market intervention, definitely, and I don't think any of us harbor any illusions about that.

Senator ROCKEFELLER. I understand that, and I'm not trying, incidentally, Mr. Secretary, to indicate that everything should be all one or the other. I'm trying to say there should be some kind of a reasonable balance, and what I'm trying to say to you is that—or what I am saying to you is that clean coal money, if you scour the budget under current programs, is about $27 million, which I consider to be at substantial imbalance with the nuclear research effort.

Mr. VAUGHAN. Senator, I think our current effort is on the order of $250 million, that level of——

Senator ROCKEFELLER. Clean coal, Mr. Secretary, is what I am talking about.

Mr. VAUGHAN. In coal.

Senator ROCKEFELLER. I'm not talking about coal, I'm talking about clean coal, I'm talking about a specialized type of innovative research, looking toward the future.

Mr. VAUGHAN. Virtually every activity in coal R&D in the Department of Energy for I think a number of years preceding this administration, too, certainly have been aimed toward clean coal utilization because every researcher has, I think, recognized, Senator, that the prime problem with coal utilization is cleanliness.

Senator ROCKEFELLER. There is a second study to which you have referred and to which reference has been made here by other Senators.

Why do you have a second study about this matter when you have said that only competition will properly allow and set ranking?

Is this a delaying tactic?

Mr. VAUGHAN. No, sir; let me explain to you the origin of the ERAB report, which is the one I believe you refer to. The ERAB report was requested by the former Secretary of Energy, now Secretary of the Interior, Donald Hodel, in the early part of the summer of last year, if I recall correctly. It was a good faith request of his advisory board, ERAB, as a check and balance on our activities in fossil energy. I think it was a good management tool to request his advisory committee to look at our activities and comment on them. And that is what he did.

And I frankly, as the Assistant Secretary responsible for that area of activity, welcomed that overview.

Now, subsequent to that charge to that advisory committee, the Congress saw fit to create the clean coal technology requirement in

last fall's continuing resolution. So they were really two totally separate activities, and they are linked only in the sense that they relate to the—they do have the same subject, clean coal use. But again, that would go back to a point I earlier made. Everyone recognizes that the main problem with coal utilization is its cleanliness.

Senator ROCKEFELLER. Mr. Secretary, I have only one more question, but let me just make this statement, that the special study or the second study that are referring to is not the one I was referring to. The one I was referring to is your own Department's followup on this.

Mr. VAUGHAN. Oh, excuse me.

Senator ROCKEFELLER. Not what you were referring to.

Mr. VAUGHAN. I'm sorry, Senator. If it is the offer to create a further report, it is the Secretary's feeling that it may be useful to furnish yet another view of this subject and to try to assist those who are interested in some ranking of technologies.

I have, as I think you heard me a few moments ago, responding to one of your colleagues' questions, talked about what I believe are some difficulties in trying to achieve that goal, but we intend to try it, and it will be my recommendation, sir, that that should be an independent group because we have certainly had our—we have had ERAB look at this subject. We at your direction have, with certain strictures, looked at this subject, and we thought it would be useful to offer additional information that takes a broader scope.

However, we have been quite candid that for it to be meaningful it will take some time. It is not a delaying tactic.

Senator ROCKEFELLER. With the permission of the distinguished chairman, can the 100th Senator ask one more question?

Senator FORD. Mr. Vaughan, I understand, has an appointment shortly. If you would limit it to one more question, I think it would probably please Mr. Vaughan, but I have been enjoying your approach, Senator.

Senator ROCKEFELLER. I only have one more.

Mr. Vaughan, Secretary Vaughan, there are a number of proposals that fall within the clean coal submissions that in fact do more than help the coal industry per se or the utility industry per se. For example, there is one proposal that just happens to be from the State of West Virginia that would use a clean coal process in steelmaking. If it works—and I am not in the position to pass judgment on the technical merit of the proposal—it could mean that the steelmaker would reduce or eliminate the need for coke, eliminate some of the environmental difficulties of coke production, and make a more competitive steel prospect for the future which is pretty big news in our part of the country, and happily, use West Virginia and domestic coal.

Now, I refer to the Weirton Steel Corp. which has been through an extraordinary industrial revolution in the last couple of years in which workers have given up approximately between 19 and 20 percent of their wages, by vote, by the vote of 9 to 1, which is an experiment of a magnitude which has never before been tried in this country and which is the largest ESOP, that is, employee stock ownership plan, program, plan, in the history of this Nation. It is

not out of the woods yet. They are doing well, but it is still an experiment, an experiment which people are watching very closely.

What makes you think that they would be able to invest in a project such as this, that is, the one which is within your clean coal submission groups, without some kind of Government help, that is, Government intervention? Why are you so anxious to throw the full burden on 8,000 employees who own the company to pay for this?

Mr. VAUGHAN. Frankly——

Senator ROCKEFELLER. My final question was not as positive as I would have liked to have stated it

Why does that not represent a form of Government intervention which is in fact entirely fair, useful to the national interest, not to speak of the interests of 8,000 people who work in the Ohio Valley?

Mr. VAUGHAN. There is certainly much, Senator, that would commend such a proposal. However, I do feel that I should point out to you that this proposal made no reference whatsoever to any form of cost sharing. It was a direct request for direct, full, public assistance.

Senator ROCKEFELLER. So it is simply ruled out of hand.

Mr. VAUGHAN. We were not running a selection process, Senator, so it was reported and characterized just like every one of the other proposals in this report.

However, if it were answering a competitive solicitation where one of the criteria was cost sharing, it would not fare well, it would be rejected out of hand for lack of that particular component if that was one of the criteria set out in the solicitation. And I would strongly suggest, and I believe people like ERAB also would strongly suggest that at this juncture, even for demonstration projects, a very heavy amount of cost sharing should be involved because that's what clearly the market will bear at this time.

Senator ROCKEFELLER. So there is no real hesitation about a subsidy for nuclear power research, but there is substantial hesitation unless the workers of Weirton Steel who own the company and gave up 20 percent of their wages don't put forward a substantial 30, 40, 50 percent of that cost sharing.

Mr. VAUGHAN. The best way I think for me to respond, sir, is that we are not comparing R&D here, we are comparing demonstration, and this is the—the reluctance is one to engage in demonstration projects. It is not a reluctance to engage in long range, high risk R&D.

Senator ROCKEFELLER. I thank the Secretary and the Chairman.

Senator FORD. I might make two observations. I serve on the Commerce, Science and Transportation Committee, and we have NASA under our jurisdiction, and some of the finest medical research this country has seen in a long, long time has developed from the so-called space program which has benefited all Americans.

A baby born today has a life expectancy of 75 years. The taxpayers are paying most of that. Every once in a while we get to launch a satellite that won't work, but nevertheless, all of that has been funded and it has been funded now for what, 25 years. And all of us reap the benefit from that.

I think the country could reap benefit from clean coal technologies.

And my second observation is about priorities. You have your priorities, I have mine. I said earlier I would like to see the option, have some mix and some fairness about it, but there seems to be all in one place and zilch the other. But I think the race to develop clean coal technologies is on, and that race is endeavoring to develop this technology before changes in the Clean Air Act, and if they come about, then you've closed the door on all these technologies, and it would do no good, then, to continue.

So there will be some questions. I have a hunch I would like to ask today, but I will submit those in writing and ask the Secretary to expedite the answers of them if he can, and I hope that the Secretary can reach his next appointment without being too late.

So I thank you for your testimony today.

Mr. VAUGHAN. Thank you, Mr. Chairman. I particularly appreciate the consideration with the next appointment. We will respond to your questions and those of the committee that are submitted as quickly as we can.

Thank you.

Senator FORD. Since you are one of our favorite witnesses, Mr. Vaughan, I hope the next time that you will not close us out with an appointment, you know, after you have only been here a little over an hour. That doesn't give us time to even get warmed up.

[General laughter.]

Mr. VAUGHAN. I think I got the message, Mr. Chairman.

Senator FORD. Mr. Reichl, the Assistant Secretary—no, Chairman, Clean Coal Technology Panel, Energy Research Advisory Board.

Good to see you again.

Mr. REICHL. How are you, Senator?

Senator FORD. Mr. Reichl, if you want, your statement will be included in the record. If you care to summarize it, why, we would be glad to have that, and we appreciate you offering yourself for some questions.

STATEMENT OF ERIC H. REICHL, CHAIRMAN, CLEAN COAL USE PANEL, ENERGY RESEARCH ADVISORY BOARD, DEPARTMENT OF ENERGY

Mr. REICHL. Thank you, Mr. Chairman. I appreciate the opportunity to appear before you here this afternoon. I should add that I had the pleasure of appearing before a very similar committee on the same subject this morning, and it is important that I pursue this on the basis that I haven't changed my mind having lunch down here, and I will be careful with that.

So if you don't mind, I will use the same testimony I used this morning.

By way of introduction, my name is Eric Reichl, and I appear here as the Chairman of the Energy Research Advisory Board Panel which issued a report on the Clean Coal Use Technologies. I am happy to hear Assistant Secretary Vaughan make the point that this panel was convened based on a request by Secretary Hodel on April 24 last year, long before this famous $750 million

reserve existed. There was apparently in his mind enough concern about the program so that he wanted an independent review. That was the way we got started.

We had the benefit of an advisory panel which included members from industry, from academia, and from government which among themselves had excellent expertise and competence in all the areas of clean coal use.

I should like at this point to spend a minute on the question of scope. I think from some of the previous comments, you had the feeling we weren't quite clear to recognize that what we are talking about is using coal in combustion in furnaces of minimum size, let's say, and it is quite important that we distinguish that problem which is referring to 90 percent of all coal use, I might add, from the synthetic fuel activities which of course have also been in the center of attention, and also in the DOE program.

The big demonstration plants and projects which Assistant Secretary Vaughan mentioned earlier were not in that area. There were demonstration projects in the synfuel area which DOE had attempted in the 1979–80 period.

I would like also on this issue of overlap between combustion and synthetic fuels, it's important to me because as you know, I do wear another hat as the Director of the SFC. The specific area I want to clarify is the gasification of coal. To the extent that that is used in synthetic fuels, it involves the gasification under pressure with oxygen. This is the centerpiece of the program as we now hope to pursue it in the SFC. It is also a very excellent way to use coal cleanly, and so recognized, and in fact, one of the largest projects in the field involves that type of technology in the cool water demonstration. We have decided not to include it in this program because it is adequately covered in the synthetic fuels side.

Conversely, the other side of this is where gasification is using air and is producing what is known as low Btu gas, gas that you must use integrally with the furnace to which it is attached, that is appropriately included in the clean coal use technologies. We have a chapter on that in the report, and I intend to leave it there.

Now, as far as the subjects concerned, again, we are dealing with the use of coal in combustion, and it is a very wide and diverse area of different technologies, and we divided the area into those segments which technically make sense, precombustion cleaning, combustion proper, and the several types of combustion which we recognized between conventional combustion and fluidized bed, primarily. We included low Btu gas combustion as an approach to burning in two stages, and all cleanup of flue gases resulting from combustion itself, and finally, a chapter on waste management which can become quite important, particularly where lime injection is used in any one form or another.

The report was issued and submitted to the full Energy Advisory Board on May 1 of this year and was adopted by the Board. It is now being printed, and you will be furnished copies shortly.

I would like, then, to have a few minutes to comment on five specific questions which I understand have been asked frequently with regard to this clean coal use program.

The first one is should the Federal Government be involved in it in the first place, and how should this involvement be structured?

The Clean Coal Panel clearly believes and firmly states that the Federal involvement is appropriate. The subject ultimately is related to health and environmental issues, which is a paramount area for Government involvement. We are trying to reduce pollution.

Now, why is it so important? It is obvious from anything we know that the use of coal will continue to increase, it has steadily increased all along. We expect to burn about a billion tons of coal by the year 1995 or so, and over 90 percent of it will, in fact, be used in combustion processes. Steelmaking and synfuels are very small by comparison.

The other thing, most of this combustion will take place in electric utility facilities, and finally, and very importantly, very much of it will be used in furnaces that are currently existing, and as a result, if you want to establish any priority, the retrofitting issue is probably the No. 1 issue that we have to face.

Now, as far as Government involvement, the Government involvement, of course, is indirectly involved in the way the research gets done in the industry about which we are talking here, namely, the electric utilities. It has already been pointed out that their ability to spend money on R&D is prescribed quite tightly by the utility commissions to which they report, and it is evident that there is simply not enough money available from that source, although the amount is substantial. It is very well handled, but it isn't enough, and the panel believes, and so stated, that the Federal Government should make up the difference.

Now, when it comes to how do you structure this program, of course, the question was not asked of the panel at the time, but we did discuss it, and the panel sees no reason to change the existing setup. We believe that the program should be essentially an increase in the clean coal use program already in place and already administered by DOE. The key issue is that of policy regarding the scale of effort which is now followed by DOE and which we think is inadequate.

We believe as far as the capability to administer such a program, to make the choices of what project to support, that the DOE staff is entirely adequate and entirely competent to select the projects and to administer them. So we would recommend inherently against any change in structure.

The second question that comes up is what is the amount of Federal contribution that should be provided? The panel report goes at it this way. It tries to arrive at an approximate cost of a total program covering all these generic technologies, and there are some 13 to 15 of those included in the report. It assumes that if each one of them would be pursued to the level of demonstration which is adequate for subsequent adoption commercially in the electric utility industry, that this could be done over a period of maybe 5 to 7 years, and that the total cost, if you were to support only one technology in each generic type, would be in the range of around $2.4 billion total cost.

Now, we also recognize that it is most unlikely that all of these generic technologies will reach that stage. Probably some will fall by the wayside, so that the total cost would be less than that.

Then the panel thought that a contribution—this is a very difficult number to back up with any hard numbers—is that about one

third, on the average, contribution by the Federal Government would bring the private sector into the picture to carry this project to completion. If you agree with that number, you arrive at something like $150 million annually for this 5-year period, and this needs to be compared with about $50 million which are currently in the clean coal use program as we understand the DOE budget. So you are looking at an addition of roughly $100 million a year over a period of maybe 5 years.

I might add the panel did not consider or concern itself with where these funds would come from but simply arrived at an approximate number. We did feel that if you relate the amount of money budgeted, namely, the $50 million, and compare that with the total research dollars spent by the Department, there was an imbalance if you compare the area that it deals with with the importance it has to our way of life.

And we believe that one of the key energy issues over the next 25 years will in fact be the clean combustion of coal. It will be a dominant issue overall.

Now, the third question we also feel is coming our way all the time is which technologies show the greatest potential? It is this issue of ranking that came up here a little while ago, priorities. We feel very, very strongly about that one. The panel made a specific effort to explain why no such ranking could be given or should be given. The preferred answer is extremely site specific and obviously will differ in different applications, and there is absolutely no way to select one preferred system.

Now, when we talk about competitive selection of project, obviously within a given type of project you can issue an RFP and get competitive bids and then select the best one, but you cannot compare, say, precleaning of coal with flue gas combustion although there is a relation there nevertheless.

But to give you a feel for why this is so, let me give you a series of factors at any given site which will impact on this choice of which is best.

For instance, whether it is a new facility, and addition of capacity or the fixing of an existing one has a major impact. In general, it is much, much easier to come up with the clean coal use technology if you start from scratch. There are some very good ones already in hand. It is much more difficult to fix up all the different units that exist.

You must consider the size of the plant, the remaining life it has. We must find out whether there is even space for any cleanup facility to be added. We need to know what coals are available, et cetera, et cetera.

So the panel concluded that a sound program should offer choice and leave the selection to the users, and in practice, let the marketplace make the selection by its willingness to put up 50 percent of the cost or more. These are very expensive projects. If you get a 50-percent contribution, we feel it is an assurance that early commercial use will appear, as soon as the project is finished. No one is going to put up even half that money unless he has a conviction that it will be used.

The fourth question we frequently get is what is the scale of R&D, what scale projects should this program include, and this re-

lates to the key issue on which we have a somewhat different view than DOE itself. The panel did make the point that we felt it was important that the Federal support should continue through R&D and demonstration, and the word means different things to different people, and it means different things for differnt technologies, I should add, but that the testing should in principle be at a scale such that no further risks are incurred when the system is put on line commercially in an electric utility station.

In most instances we feel that the scale will be in the 100 megawatt range or higher, and it costs a lot of money, for instance, to set up shop, to test a slurry combustion unit in a 100 or 200 megawatt boiler, but that is the kind of program we are talking about.

And the last question that we frequently got was that what is the proper minimum cost sharing from the private sector? We suggested and we have heard that discussed several times, that a 50 percent private coal funding would be required, should be a required minimum in the DOE Program, particularly when it reaches the demonstration phase.

These were the main points I wanted to make, and I obviously would be happy to answer any questions.

[The prepared statement of Mr. Reichl follows:]

STATEMENT OF ERIC H. REICHL, CHAIRMAN, CLEAN COAL USE PANEL, ENERGY RESEARCH ADVISORY BOARD, DEPARTMENT OF ENERGY

Mr. Chairman,

My name is Eric H. Reichl* and I am appearing before your Committee to discuss some aspects of the report on Clean Coal Use Technology about to be issued by the corresponding panel of the Energy Research Advisory Board, or ERAB, of the Department of Energy.

I have been a member of ERAB since 1979 and I am the chairman of The Clean Coal Use Panel which was established in April 1984 in response to then Secretary Hodel's request. He asked ERAB to review the subject and to recommend an appropriate program for Research and Development for DOE.

We have been most fortunate in being able to assemble an outstanding group of experts from within and outside ERAB, who could bring to bear their wide experience with the several areas of clean coal use. To give a logical structure to the report, the subject which is quite broad and diffuse was divided into three major sections: these are Pre-Combustion systems, Combustion proper and Post-Combustion. Combustion was sub-divided into Conventional Combustion, essentially pulverized coal burners, and fluidized bed combustion, and a section on solid-waste management was added. Further, to obtain a feel for the scope of the future markets for coal and the specific clean coal technologies to fit them, Mr. Joseph Mullan, V.P. of the National Coal Association, joined the panel and prepared a projection of coal utilization in the U.S.

Each area was then assigned to one or two panel members for review and recommendations. The key individuals and authors of their respective sections were as follows:

Coal preparation: Mr. William N. Poundstone, retired Executive Vice President of Consolidation Coal Co. and Dr. Edward Rubin, Director/Center for Energy & Environmental Studies/ Carnegie-Mellon University

Conventional Coal Combustion: Mr. John Landis, Senior Vice President, Stone & Webster Eng. Co. and Mr. Frank Princiotta, Director of Industrial and Environmental Laboratory/EPA

Fluidized Bed Combustion: Mr. Kurt Yeager, Vice President/ EPRI-Coal Combustion Division

Post Combustion Control Technology: Mr. Larry Papay, Senior Vice President/Advanced Engineering, Southern California Edison Co.

Waste Management; Dr. Edward Rubin (see above.

*A brief Resume of my experience is attached for your records.

Throughout the preparation of the reports the panel members visited selected DOE facilities and received full cooperation and help from DOE staff at all times. It is a pleasure for me to acknowledge this assistance at this occasion. And I would especially like to recognize the substantial time and effort contributed by the panel members, all of whom are heavily engaged in their regular activities in industry, academia or in government service.

The seven separate sections of the report were circulated for comments to all panel members, and the entire panel met three times for discussion to assure as good a consensus as possible. A summary was prepared by me to highlight the major findings.

The finished DRAFT was then submitted to the entire ERAB for consideration at the quarterly meeting of the Board on May 1-2.

Speaking now for the Coal Use Panel as a whole I would like to point out for you the key findings about DOE's R&D program on Clean Coal Use Technology, but before I list them I would like first to set the stage by noting a few general observations:

- An order of magnitude set of figures for all energy related R&D expenditures at this time shows the following figures in $'s per year:

Private industry, companies: $3,500.- Million (including ($3,000 MM for oil exploration)

Private industry, regulated: $450.- Million (EPRI plus GRI)

Government: DOE, Total: $3,100.- Million ('86 Request, excluding weapons)

To this one might add, maybe $4-500 million/yr for the Synthetic Fuels Corp. if it is permitted to complete the limited program it has proposed.

Thus the total U.S. energy related R&D could approach $8 Billion; $3.6 of this spent is spent by the government.

- The figure includes some $150 million requested by DOE for FY '86 for Fossil Energy, of which some $55 million aim at Clean Coal Use. This then would represent about 1½% of all Government R&D related to energy.

° In a nutshell, Mr. Chairman, the panel suggests that this figure be increased by a factor of 2 to 3. This is obviously not any massive rearrangement of the R&D budget as a whole and should be achievable within the available total funds.

° The panel suggests that in view of the quite obvious, major and increasing, contribution the combustion of coal will make to U.S. energy supply over the next 25-30 years, it warrants immediate and significant attention, larger than it is currently receiving. This applies both to Government and the private sector. The evident need is for improved cleanliness when coal is used as fuel.

That is the key message of the panel's report. Now allow me to note a few observations made by the panel:

° Coal consumption in the U.S. will approach the billion ton per year level in the early 1990's. Some 80% of it will be consumed by electric utilities and a good part of the balance in industrial boilers and furnaces.

This combustion is THE coal use which requires attention with main emphasis on the large utility coal burner.

° Equally important is the fact that the bulk of this coal combustion will continue to occur in existing boilers. This then sets a priority on clean coal use technology which can be retrofitted to existing facilities.

° The panel further notes that there are a wide range of alternate technologies to be considered and the preferred answer will be extremely site specific. Therefore there is absolutely no way to select one preferred approach.

The relative cost effectiveness at any given site depends on a large number of factors which will vary all over the place.

To name a few: size of plant, age, type of coals available, at what price, plant design, even available space and existing or expected, regulations on emissions, etc.

A proper R&D program must offer a choice of approaches leaving selection of the technology to the user.

• In effect the panel notes, that the marketplace will be the best selection mechanism for choosing the technologies which deserve support.

In turn this is best determined by insisting on a major private sector contribution and this must increase as a technology moves into the critical and costly demonstration phase.

• This led the panel to a particularly important comment on DOE's R&D policy.

No R&D program is ultimately useful unless it leads to commercial acceptance. The key step required for this varies of course among industries, but electric utilities must be uniquely wary before any innovation can be adopted and there is simply no way to bypass the need for large, even full commercial, scale testing.

As matters stand, DOE policy has frequently kept the Department from participation in such test-, or demonstration programs. The panel recommends that DOE do participate, or even lead, in such tests.

This does not deny the need for major private sector contribution. In fact DOE may be a less than 50% contributor, but DOE leadership is needed.

• The panel fully agrees with DOE on the urgent need for increased exploratory and basic research. In fact our fundamental knowledge has been exhausted and we badly need new insights. DOE has unique capabilities in the several National Laboratories which should be mobilized in this direction. I want to be clear, the panel is not thinking in terms of engineering, or process-development, but of basic knowledge about the composition and distribution of mineral matter in coal, its behavior in a flame, etc. One of the finest examples of such work is the laser supported combustion research at Sandias Livermore laboratory, to give you a feel for the type of study we need.

DOE is quite properly planning to continue or even to increase Basic Research in coal related subjects. Incidentally, in terms of cost this is minor compared to the overall budget.

• Time obviously does not permit us here to go into any detail of the several specific suggestions the panel made in its report. I would like permission to place the report into my testimony as an addendum and urge you to read the individual sections where the rationale for the various technologies is presented.

You will find near the end of each section a Table of the order of magnitude, in dollars and time, required to bring the technology to commercial acceptance. Be sure to understand this is NOT the amount suggested for DOE support, but the total cost of a program.

• To give DOE a ready comprehensive view these figures were summarized in a table (on pages 15A to E) and to be consistent, the total costs of a possible 5 year program for the years '86 to '90 were given for each technology. The total, about $2.4 billion includes:

$120 million	for Precombustion, or cleaning technology
$628 million	for Conventional Combustion
$930 million	for Fluidized Bed Combustion
$100 million	for Airblown gasifiers, or 2-stage conbustion
$562 million	for Post-Combustion, flue gas clean-up, and
$ 60 million	for Waste Management.

It should be obvious, that not all of these options, some 15 to 20 are discussed in the reports, will come to fruition, thus the total spent would be substantially less.

And finally, the report suggests an area of magnitude contribution towards this overall program which might be appropriate for DOE. The panel's figure is about 30%, or $740 million over the 5 years. This compares to $275 million, DOE would contribute if the '86 Budget request were maintained without change thru 1990. This corresponds to some 2 3/4 times greater efforts in clean coal use R&D than is now contemplated.

Although this is a major change for this program, it is not major in the context of DOE's Total R&D budget. But it is an important adjustment in emphasis which the panel believes to be called for if we want to keep the coal option open.

• I have tried to give you a brief overview of the ERAB report on Clean Coal Use Technology and would like to conclude by thanking the Committee for this opportunity to present our views.

I shall be happy to try answering any questions you may have.

BIOGRAPHICAL RESUME: ERIC H. REICHL

Personal: Born in Vienna, Austria, December 3, 1913
U.S. Citizen - Married, two daughters

Education: Equivalent degree to MS Chemical Engineer
Technische Hochschule - Vienna, 1937

Employment:

1938 Babcock & Wilcox Company
Field Engineer (construction)

1938-1944 Winkler-Koch Engineering Company, Wichita, Kansas
(and subsidiaries)
Research, plant design - construction, operations

1944-1946 Stanolind Oil & Gas Company, Tulsa, Oklahoma
(now Standard Oil of Indiana)

Process research on synthetic liquid fuels including tour of duty with U.S. Navy as civilian technician to evaluate German synthetic oil industry - January - June 1945

1946-1948 California Research Corporation
(Standard Oil of California)

Process Research - Petrochemicals

1948-1954 Consolidation Coal Company - Research Manager

1954-1962 Consolidation Coal Company - Director of Research

1962-1974 Consolidation Coal Company - Vice President, Research*

1974-1978 Conoco Coal Development Company - President
(subsidiary of Continental Oil Co)
Retired 12/31/78

1979- Consultant

Professional Associations:
American Chemical Society
American Institute of Chemical Engineers
Member, National Academy of Engineers
Member, Energy Research Advisory Board (ERAB)/DOE
Past Member, Research Coordination Panel/Gas Research Inst.
Member, Gov't. Tech. Adv. Comm./USERDA 1973
Chairman, Coal Task Group/National Petroleum Council Energy Study - 1972
Chairman, Coal Conversion Panel/National Academy Energy Study (CONAES) - 1977
Past Member, Liaison Committee of International Institute for Applied Systems Analysis

*Note: Consolidation Coal Company's research and development program includes pipelining of coal; conversion to liquid, gases and chemicals; sulfur recovery; continuous coking.

3/19/82

Senator FORD. Mr. Reichl, you were very straightforward and very informative, and I compliment you for your opening statement.

I believe you stated that coal consumption in the United States will approach a billion tons in the 1990's, and 80 percent of which will be consumed by electric utilities.

Mr. REICHL. I think the number is approximately that.

Senator FORD. Approximately that.

Mr. REICHL. Yes.

Senator FORD. Well, if we are in the ballpark, we will accept that.

What does this forecast assume about the current debate over sulfur emissions and acid rain?

Mr. REICHL. Well, it doesn't make any quantitative assumptions as far as the impact from it, but it is pretty obvious, the more we burn, the more we will emit, and the more the pressure will rise to do something about it.

I think the urgency for coming through with this program increases with time and it will increase quite rapidly, and as I tried to make clear, I don't know of any other energy issue that is really quite as important.

I happen to compare it with synthetic fuels, for instance. I think this is the more urgent project.

Senator FORD. Are you saying, then, that the projection of a billion tons is based on today, if we continue whatever regulations we have today without any changes?

Mr. REICHL. Well, it is based on a little more than that, Senator, Mr. Chairman. We know, of course, that a good bit of those tons will be burned in facilities, A, that exist—in fact, most of it will be burned in the facilities which already exist, but we also have in the pipeline, in construction or committed, substantial additional capacity of coal burning units that will come on stream between now and then. When you add that and assume certain continued growth, it will come close to that figure.

Obviously there is an uncertainty in the 2,000 year range.

Senator FORD. Well, if any of the recent acid rain bills is enacted, which I guess mandate reductions in sulfur emissions of around 10–12 million tons, what would coal consumption be in the 1990s, given the current technology?

Mr. REICHL. Oh, I think it would be the same.

Senator FORD. You think it would be the same?

Mr. REICHL. Yes; I think we will suffer, we will be mad because it will be dirty. We will try, of course, to clean up. I think that no utility is willingly going to violate the law. If they are forced to invest in clean-up, they will try to find means to do so, either by buying lower sulfur coal or by adding retrofit technology. The trouble is that the technology currently available is not as good as it could be or should be, and it will cost a lot more if you do not carry out this program.

But I do not believe that the coal demand can be reduced. You can reduce some, obviously, by using some gas. We have had some comments about that this morning, that it is a good idea, that is a clean fuel, but in the long run, I think coal will be required as the mainstay of power generation for some time to come.

Senator FORD. Well, if this Congress—I am talking about this Congress now—enacted legislation requiring a 12 million ton reduction in SO_2 emissions by the early 1990's, what would be the effect on developing clean coal technologies?

Mr. REICHL. It would speed it up even absent any government support, obviously, but I think it would be a wise thing to do to for once try to get the house in order before the roof burns down. I think that the ultimate outcome of things is obvious, we do need to do a better job of emission control, and I think there is enough potential available to carry this forward.

I think that the difficulty we have is simply that the industry that is impacted here, which is the regulated electric power industry, is not able under its system of research support to carry the job forth fast enough.

Senator FORD. Do you agree with my observation earlier that we seem to be in a race, at least my feeling is that we are in a race as it relates to acid rain legislation that might be passed in order to have this clean coal technology in place prior to that?

Mr. REICHL. Yes; I think that it would be nice to see the program well under way before the legislation is committed.

Senator FORD. I thank you, Mr. Reichl, and I am always amazed at your easy flow of answers, and even a boy from Yellow Creek can understand what you're saying. I'm grateful to you.

Mr. REICHL. Thank you. Considering my accent, I consider that very nice praise.

Senator FORD. With your accent, that makes it even better.

Mr. Chairman, I would be glad to turn it back over to you.

Senator WARNER [presiding]. I understand we had a little excitement while I was gone, and I apologize——

Senator FORD. No; there's no excitement. Where was the excitement?

Senator WARNER. Well, that's all right. The record speaks for itself. I had to join my leader for the preparation of the management of the Defense bill for which I have responsibilities tomorrow morning at 9 o'clock.

Now, thank you, Mr. Reichl. I am familiar with your testimony, and I will submit whatever questions I may have.

Senator FORD. Jay is next.

Senator WARNER. Oh, I'm sorry. I understood that you were finished.

Mr. Rockefeller, did you wish to propound questions?

Senator ROCKEFELLER. I have simply one.

Sir, since the Department of Energy has really rolled out a kind of a free market philosophy the likes of which I haven't heard since I guess I would have if I had listened to my great grandfather say anything on any particular day in any given week——

[General laughter.]

Senator ROCKEFELLER. They really don't appear to me nor does the administration to have any great desire to fund the clean coal program.

Now, the distinguished chairman of this subcommittee has indicated that he would like to see that happen, and as is so frequent with matters with respect to coal, he's right on target.

But with all of that sort of approach and philosophy in mind, is it your judgment that if there is money that is put into this program, that is, the clean coal program, by the Congress, that the Department of Energy will faithfully implement it?

Mr. REICHL. Without reservation, yes.

Senator ROCKEFELLER. Thank you, Mr. Chairman.

Senator WARNER. Thank you.

Thank you, Mr. Reichl.

We will now have a panel, Mr. Splencer, Mr. Disbrow, and Mr. Webb.

First, the Chair wishes to announce that I have just met with Senator Domenici. He expresses his regrets at not being able to be here today and to Chair the subcommittee of which he is the chairman, and he expressed his appreciation to all witnesses and others in attendance for showing an interest in the hearing.

We will start off with Mr. Spencer, vice president, Advanced Power Systems Division, Electric Power Research Institute.

STATEMENT OF DWAIN F. SPENCER, VICE PRESIDENT, ADVANCED POWER SYSTEMS DIVISION, ELECTRIC POWER RESEARCH INSTITUTE

Mr. SPENCER. Thank you, Mr. Chairman.

I greatly appreciate the opportunity to address this subcommittee relative to the important role of the Federal Government in stimulating the development and demonstration of emerging clean coal technologies. As you have indicated, I am Dwain Spencer of the Electric Power Research Institute.

I have submitted a total statement for the record, and I would offer that to you, and I will simply try to highlight a few comments from that statement.

Senator WARNER. Without objection.

Mr. SPENCER. As you may know, in many ways, EPRI is a key catalyst in bringing private sector technology and funding forward in cooperation with the Federal Government, specifically the Department of Energy, the Environmental Protection Agency and the U.S. Synthetic Fuels Corporation. It is this cooperative attitude and the continuing need for Federal support for development and demonstration of emerging clean coal technologies on which I would like to focus my remarks.

Specifically, there are three major elements that I would like to bring to your attention today. First, the rationale for a Federal role. With the ever-increasing stringent Federal emission control requirements which have been discussed today which are being placed on or considered for coal based powerplants, it is clear that advanced coal technology is necessary to make these plants economically viable as well as environmentally acceptable, and I think we must maintain, as so well stated earlier, the balance between environmental need and protection as well as the economics for us as ratepayers as well as taxpayers.

It is clear that coal will be the primary fuel source for new plant additions for the electric power industry in the future. Advanced coal technologies to control all acid rain precursors, both SOx and NOx should be emphasized in a clean coal technology program. As

an example, Mr. Chairman, I would simply state to you that a new emerging clean coal technology called coal gasification, combined cycle systems, which has recently been demonstrated at the 100 megawatt cool water combined cycle plant in California, is able to achieve one-tenth of the new source performance standards on SO_2, one-tenth of the new source performance standards on NO_x, and one-thirtieth of the new source performance standards on particulate emissions.

It is these type technologies, which we must develop and demonstrate at full scale in order to enable the electric utility industry to begin to anticipate future environmental requirements rather than forever having to be in a position to respond to them.

And it is only in an anticipatory fashion that we can see one can develop truly economically competitive technologies and still meet these very tight emission control requirements as necessitated by public law.

We believe also that modular power system additions are the key to the future of the industry. With uncertain load growth and in many cases low load growth, it will be necessary to add increments in the few hundred megawatt to—say 200 to 400 megawatt capacity range. There are at least three or four very good technologies that are emerging which could benefit greatly from a clean coal technology bill. These are, at least in my order of priority, integrated gasification, combined cycle power systems, atmospheric fluidized bed combustion systems, coal gasification phosphoric acid fuel cell systems, and there are other advanced coal technologies which also have potential both for being economically viable and also good control of acid rain precursors.

So that we do believe that there is a clear identification in a technology sense of good candidates for the emerging clean coal bill that you are considering.

I should also emphasize to you that we need to develop not a single capability in each of these systems, but we believe two or three technologies should be developed, or two or three processes within each technology category. They are expensive projects. There is no doubt about that. The cool water project itself was capitalized for approximately $260 million and the operating costs for 5 years of operation are about $250 million. So totally a project cost in the neighborhood of $500 million.

That probably is typical, on the low side, and these project costs will run between $500 million and $1 billion.

Certainly I concur very strongly with the comments that Mr. Reichl just presented to you that 50-percent cost sharing by the private sector should be a minimum requirement for any demonstration projects at this scale. However, I do believe, based on the submissions that have been made by the electric utility industry, many of which were endorsed by EPRI, that we stand ready to provide that 50-percent commitment if the Federal Government is prepared to provide their 50-percent commitment in concert with us.

I will just leave you with one other thought, if I might, and that is that although the utility industry has not been adding significant new capacity or making new capacity commitments in the recent past, let's say, 3 or 4 years, we do anticipate with the increasing load growth, the recovery of our economy, that we are

going to experience increased electricity load growth in the late 1980's which may require additions in the early 1990's timeframe. With either nuclear or large coal-fired plants, the lead times for such units are in the neighborhood of 7 to perhaps 12 years. There is no way we can add that type capacity.

We are likely then to have to turn back to combustion turbines which can be added to utility systems in a rapid fashion, but they utilize premium fuels. One of the real great benefits we see for gasification combined cycles is that first we would add these combustion turbines in a mode where they would be used for peaking duty, using premium fuels, and then subsequently design the plant so that we could substitute coal gasification, so therefore, converting from our premium fossil fuels to our coal-based systems, and not only the coal based systems in general, but particularly those which utilize eastern and midwestern high sulfur bituminous coals.

So we believe that again a phased implementation approach which carefully considers both the needs of the industry from a power delivery standpoint as well as the technological alternatives that appear to be emerging. This is an ideal time to proceed with a program such as you are considering.

And we greatly appreciate the opportunity of expressing our thoughts.

[The prepared statement of Mr. Spencer follows:]

THE IMPORTANT ROLE OF THE FEDERAL GOVERNMENT IN STIMULATING THE DEVELOPMENT/DEMONSTRATION OF EMERGING CLEAN COAL TECHNOLOGIES

Dwain F. Spencer
Vice President
Advanced Power Systems Division
Electric Power Research Institute

Hearing on Emerging Clean Coal Technologies

Testimony Presented To:

Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources
United States Senate
Washington, D.C.

May 16, 1985

I) Introduction

Mr. Chairman, I greatly appreciate the opportunity to address the subcommittee relative to "The Important Role of the Federal Government in Stimulating the Development/Demonstration of Emerging Clean Coal Technologies." I am Dwain Spencer, Vice President of the Advanced Power Systems Division of the Electric Power Research Institute (EPRI). In this capacity, I am responsible for EPRI's programs in coal gasification, coal liquefaction, advanced power cycles, and renewable energy systems. In addition, I have served as a member of the Department of Energy's Fossil Energy Advisory Committee since 1976 and am presently the Chairman of the newly formed Synthetic Fuels Research Institute. In these capacities, I have very close contact with federal government programs and staff, the U.S. Synthetic Fuels Corporation, a broad sector of the U.S. and foreign electric utility industry, and university and private industrial sector personnel and programs. In many ways, EPRI, as a non-profit research and development organization, has served as a key catalyst in bringing private sector technology and funding forward in co-operation with federally supported efforts of the Department of Energy, the Environmental Protection Agency, and the U.S. Synthetic Fuels Corporation. It is this co-operative attitude and the continuing need for federal support for development/demonstration of emerging clean coal technologies on which I would like to focus my remarks.

As you know, Mr. Chairman, the U.S. electric utility industry is the nation's largest user of coal of all types, consuming over 660 million tons of coal in 1984, or about 75 percent of all U.S. coal produced. This coal produced over 55 percent of our total electric power in 1984 and was approximately a 70 percent increase in utility coal consumption in the last ten years. With the present difficulties of financing and licensing nuclear power plants, and limitations on the use of oil and gas for electricity production, we anticipate that the electric utility industry use of coal will grow to over a billion tons per year by the year 2000. If our economy expands more rapidly than presently projected, it is conceivable that electric utility demands for coal will even exceed this estimate. Therefore, the electric utility industry's interest in consuming coal in an economically competitive, environmentally benign manner is an ever growing priority requirement.

EPRI strongly supports the initiatives taken by the Congress in stimulating interest and support for Emerging Clean Coal Technologies. As evident by the large number of submissions made by the electric power industry, many of which were specifically endorsed by EPRI, we believe that now is the time to develop and demonstrate the most appropriate technologies for future electric

utility use of coal. The 100 MWe Cool Water Coal Gasification Combined Cycle Project is EPRI's first full scale module of a commercial plant for bringing advanced coal technology to the electric power industry and serves as an excellent example of co-operative private sector/government (Synthetic Fuels Corporation) co-operation. As you may know, the Cool Water plant has just recently passed its first anniversary of operation, and, to date, has exceeded our expectations in both performance and on-stream availability.

I would now like to focus my remarks on the rationale and importance, assessment criteria, and priorities for a federal program in support of Emerging Clean Coal Technologies.

II) Rationale for a Federal Role

With the ever increasingly stringent federal emission control requirements being placed on or considered for coal based power plants, it is clear that advanced coal technology is necessary to make these plants economically viable as well as environmentally acceptable. In order to provide the electric utility industry, and other industries which depend on coal for energy or power, with a range of options to achieve these requirements, a federally sponsored assistance program in coal R/D&D is essential. Let me first discuss the present situation relative to emission control requirements.

A. Environmental Requirements

Since passage of the Clean Air Act in 1963, and associated amendments in 1970 and 1977, control of SO_2, NO_x, and particulate emissions from large fossil fired generation has become a requirement. The requirements of the 1977 legislation to preserve air quality included regulations for Prevention of Significant Deterioration and Non-Attainment. The structures of the Clean Air Act reflect Congressional intent to combine two general approaches to air pollution control, a goals-oriented approach and a technology-based approach. The goals-oriented approach is directed at maintaining specific ambient air concentrations of certain pollutants and is embodied in the National Ambient Air Quality Standards (NAAQS). The technology-based approach is directed at limiting air pollution at the source and is manifested in the National Emission Standards for Hazardous Air Pollutants (NESHAPS) and the New Source Performance Standards (NSPS), Prevention of Significant Deterioration (PSD) and Non-Attainment (NA) regulations. Under certain conditions, each of the NSPS, PSD or NA regulations may be the controlling regulations for a new power plant. During the eight years

since passage of the CAA Amendments of 1977, a significant percentage of new steam electric power plants have been permitted at NSPS emission limits. However, the potentially more stringent PSD requirements can be the controlling regulations depending upon the policy of the permitting authority and specific State Implementation Plan (SIP) requirements.

A key controlling element of the CAA of 1963 and associated amendments is the restriction of emissions for new coal fired plants to ten percent of the SO_2 from the coal plant or a maximum of 1.2 pounds of SO_2 per million Btu (or lesser controls where the coal sulphur content is lower). However, there remain over 200,000 MWe of old coal fired power plants which exceed these emission limits by varying degrees. It is the emissions from these older power plants that has been the focus of various forms of so-called "acid rain" legislation which would require further SO_2 emission reductions by six tc twelve million tons of SO_2 per year by the mid-1990s. Without discussing all of the pros and cons of the situation, suffice it to say that the threat of this legislation becoming law is a major source of concern to electric utilities, as well as a major uncertainty in their ability to plan for the future. In my judgment, the requirements of such a law which likely would require "scrubbers" to be added to many existing coal fired plants, could be counterproductive to environmental interests in the long run. A policy which enables the utility industry to substitute new more advanced control technology options such as integrated coal gasification combined cycle (IGCC) and atmospheric fluidized bed combustion power plants in the mid- to late-1990s would seem much more amenable to long term control of undesirable emissions.

In addition to the CAA requirements, the Clean Water Act (CWA) of 1977 is the basis for regulation of liquid effluents from power plants. The discharges from new power plants are controlled by NSPS requirements which limit concentrations of specific pollutants from these plants.

Finally, the Resource Conservation and Recovery Act (RCRA) of 1976 is the basis for regulations of utility solid waste streams. RCRA provides two mechanisms for identifying hazardous wastes. The first mechanism defines hazardous wastes on the basis of characteristics including: ignitability, corrosivity, reactivity, or toxicity. The second mechanism, listing, identifies wastes considered hazardous due to chronic effects. Toxicity is the primary question in classification of solid wastes from coal combustion or coal conversion processes.

Regardless of the ultimate classification of utility solid wastes as hazardous or non-hazardous, regulations evolving under RCRA will have a considerable impact on the utility industry. Increasing stringency of federal requirements for non-hazardous waste disposal will increase solid waste disposal costs substantially for wastes such as scrubber sludge, bottom ash, or bottom ash and limestone.

B) Emission Control Perspective

Although each specific power plant and its associated coal resource would have different characteristics and requirements, Table I (attached) provides a perspective on the emisssions per annualized unit of energy output for conventional coal fired plants and two of the most promising Emerging Clean Coal Technologies, namely Integrated Gasification Combined Cycle (IGCC) and Atmospheric Fluidized Bed Combustion (AFBC) power plants. The estimates in Table I are based on a typical high sulphur Illinois coal and would generally be representative of Mid-Western bituminous coals.

Table I shows the SO_2, NO_x, and solid wastes in tons per MWe yr of output for each plant type; therefore, all estimates are on a consistent basis. It is clear that both IGCC and AFBC technologies offer significant reduction in emission of acid rain precursors over conventional coal fired plants, even those with Flue Gas Desulphurization (FGD) control systems. It is further evident that IGCC plants produce the least solid waste burden and simultaneously reduce air emissions. Both conventional pulverized coal power plants and AFBC have significantly increased solid waste disposal requirements as a result of limestone scrubbing (FGD) or addition during combustion (AFBC). Control of the characteristics of the solid waste and their disposal is a key in assessing the potential of both advanced pulverized coal fired power plant control technologies and AFBC.

Although there are many other emission control options which have been proposed, including deep physical coal cleaning, pressurized fluidized bed combustion, open cycle MHD, and coal gasification-fuel cell power plants, the results in Table I are indicative of the emission control potential for these technologies, and their respective solid waste disposal requirements.

As discussed in Section IIA, the electric utilty industry has become a key focus for federal emission control legislation. The cost of meeting these emission control standards for new, direct coal-fired power plants is estimated to be approximately 40% of the capital investment and 30% of the

total cost of power from such plants. Should "acid rain" legislation be passed, mandating electric utility reductions in SO_2 emissions of 12 million tons per year, it has been estimated that such legislation would cost utilities and their ratepayers an additional $5 to $10 billion/year (1982 $) over the remaining life of these affected units, plus the replacement costs of lost capacity which may easily exceed an additional $1 billion/year.

In light of these major potential additional costs of power for control of pollutants to protect the general public's environment, it seems only appropriate that the federal government assist the utility industry in developing advanced control technologies which show promise of being more cost effective in reducing emissions. These advanced control technologies should have two fundamental capabilities, namely a) Reduce Cost and Financial Risk and b) Provide Substantial Improvement in Environmental Control Capability. These requirements point to the need for a) development and demonstration of modular power plants that can be rapidly constructed over a range of sizes to better match demand, growth and b) advanced technologies which can meet existing, and potentially emerging, environmental requirements at reasonable cost, while minimizing the need for expensive, inefficient "band-aid" control hardware such as scrubbers.

Finally, the cost of research, development, demonstration and extended test and operations of new full scale coal based technologies is typically $300 million to over $1 billion, even for modular systems of 100 to 200 MWe. Since the electric utility industry is very "risk adverse", there is a major need for federal government/private sector cost sharing to bring these new advanced coal technologies to a state of technical and commercial readiness.

But, what has the federal government done relative to fossil and synfuels R&D expenditures? It has drastically reduced its financial commitment to advanced technologies over the last few years relative to private sector expenditures. As an example, the results of the recent Synthetic Fuels Research Institute (SFRI) survey of synfuels related R&D efforts indicate that the ratio of spending by the federal government to the private sector has fallen from 1.4 to 1 in 1979 to a projected 0.26 to 1 by the end of 1985. Although private sector spending on synfuels has remained essentially constant or increased a little, the federal government program has been reduced by over a factor of 5. A correction to this trend is clearly necessary if the utility industry is to be in a position to meet the ever increasingly stringent emission requirements with meaningful technological alternatives.

III) Technologies and Evaluation Criteria

In your invitation to submit testimony, Mr. Chairman, you invited our views on research and demonstration areas not adequately identified in the DOE report to the Congress. I have reviewed the DOE report to Congress, and find that essentially all of the advanced coal technologies, which we are supporting or believe have a potential role to play in the power industry, are included within the submissions to the DOE solicitation and are reflected in their report. As the DOE report indicates, a total of 175 responses with project values totalling over $8 billion were received. Although the report is not explicit on the federal funding requested, it appears to be approximately 50% of the total amount. Therefore it appears that a key issue is the criteria to be used in selecting the most beneficial projects and establishment of technology priorities.

Although there are a wide variety of factors which should be utilized to evaluate and select the most promising clean coal technolgoies, I would like to present a few key considerations which we have utilized at EPRI to make such judgments:

1) Does the process/technology show promise of being economically competitive with present commercial systems within the next ten years?

2) Is there a well defined process/technology development history of operation at various scales (bench scale, process development units, small pilot plant, large pilot plant) that provides confidence that a demonstration project is likely to be successful? What are the key remaining technical risks, e.g., scale-up, new material requirements, major equipment fabrication limitations, etc.?

3) Do the proposers of the demonstration project have experience in defining, conducting, and managing projects in the $100 million to $500 million range? If not, why do they think they'll be successful in this venture? Is there a clearly committed "host utility?" Is the proposer prepared to cost share at least 50% of the project?

4) Are the technical and environmental performance objectives realistic? Are proprietary process/technology rights involved?

5) How firm are the proposed costs and schedule? Has a preliminary engineering evaluation and process design been conducted? Have all elements of the plant, including off-sites, been properly considered? What are the critical path items and who are the likely vendors for these units? Have

costs for two to ten years of operation been factored into the proposal?

6) Does the proposal address the importance of test and operations planning? Does the proposer have operating experience within his team on processes/technologies of comparable complexity?

Based on our experience over the last ten years in developing and demonstrating new technologies, each of these factors must be given very careful consideration in order to enhance the probability of a successful project. In addition, I suggest that the federal government should consider whether the project could be financed totally by the private sector, and, if not, what is the minimial financial assistance necessary to make the project "go." Is the governnent prepared to vest project management and control in the private sector and willing to protect private proprietary rights to stimulate commercialization of the process/technology? Finally, is there a mechanism whereby the government can recover its investment in the process/technology if it becomes a commercial success?

IV Suggested Initial Priorities

Although it is clear that a comprehensive assessment using these or similar criteria should be made for the broad range of technologies included within the response to the Department of Energy, I will suggest an initial set of priorities consistent with these criteria for your review. These suggestions derive from our own internal evaluations of the potential of various emerging coal technologies and serve as the basis for our own priority setting. As you are probably aware, EPRI is planning to expend approximately $500 million over the next five years for clean coal technology and an additional $80 million for research relating to acid rain environmental issues.

In suggesting these initial priorities, we have considered the range of options covered by the DOE responses, but not all of the responses on a specific project by project basis. Based on the importance of introducing truly environmentally beneficial technologies at acceptable costs in the mid- to late-1990s, I believe that initial emphasis in a federal demonstration program should be focused on technologies such as IGCC, fluidized bed combustion, coal gasification-phosphoric acid fuel cell, and other key environmentally superior technologies. Emphasis on these technologies would provide a range of environmentally acceptable, economically competitive coal technologies at power plant sizes from 100 to 300 MWe, and establish an expanded competitive environment for future use of high sulphur bituminous coals.

As you probably know, the utility industry, its suppliers, and EPRI have proposed approximately $2 billion in joint projects in response to the DOE solicitation. Since many of the projects were formulated in response to the DOE solicitation with a short turnaround time, operating costs have not yet been developed for many projects and must be defined to establish total private and federal funding requirements. However, a clear, continuing commitment by the federal government to the intent of such a program would provide a very significant contribution toward establishment of a meaningful clean coal technology base.

V) Summary

With the ever increasingly stringent federal emission control requirements being placed or considered for coal based power plants, it is clear that advanced coal technology is necessary to make these plants economically viable and reliable, as well as environmentally acceptable. In order to provide the utility industry with a range of options to achieve these requirements, a continuing federal assistance program to bring these systems to commercial readiness is essential. This program must include both capital and operating support provisions to be effective in stimulating the full scale testing of the most technically, economically, and environmentally sound options. EPRI and the electric utility industry stand ready to work effectively with the federal government to achieve this important national objective.

Thank you, Mr. Chairman, for the opportunity to express my views before your subcommittee.

Table 1

Typical Effluent Streams
From Coal Based Power Plant Types
(Using 3.5% S. Illinois Coal)

Plant Type	SO_2 Emissions (Tons/MWe Yr)	NO_x Emissions (Tons/MWe Yr)	Solid Wastes (Tons/MWe Yr)
Pulverized Coal Plant (Precipators Only)	140	25	240
Pulverized Coal Plant With FGD (90% Removal)	14	8	750
Integrated Gasification Combined Cycle Plant	0.14-4	3	300
Atmospheric Fluidized Bed Combustion	7	4	1200

Senator WARNER. Well, certainly the cool water project is an excellent example of a partnership between the Federal Government and the private sector that we are trying to forge in clean coal technology, and I thank you on behalf of the chairman and the committee for making the long trip from the west coast to the east to make this very valuable contribution.

Mr. SPENCER. We appreciate the opportunity, sir.

Senator WARNER. Thank you.

Now we will hear from Mr. Disbrow, president, American Electric Power Co.

STATEMENT OF RICHARD E. DISBROW, PRESEIDENT, AMERICAN ELECTRIC POWER CO., INC.

Mr. DISBROW. Thank you, Senator.

I appreciate the opportunity to be with you today and to urge Federal support and funding of clean coal technology.

I am the president of the American Electric Power Co., a public utility holding company which through its operating subsidiaries supplies electric energy to portions of several, or seven Midwestern States, of which Virginia is one.

The AEP system relies heavily on coal as a primary energy resource. We burn between 40 million and 45 million tons of coal annually. We are also substantial miners of coal. In 1984 company subsidiaries mined 13½ million tons of clean coal.

I appear before you today representing the Clean Coal Technology Coalition. The coalition is an ad hoc group of utilities, equipment suppliers, coal companies, architect, engineering, and construction firms, and the National Coal Association. Coal represents a major domestic resource upon which we can base the Nation's energy future and move a step toward energy independence. Our Nation will need more, not less, energy in the years immediately ahead and into the next century, and coal can assume an increasing share of those future needs if we can learn to use it more efficiently, in a more environmentally acceptable manner.

Now those twin objectives can only be realized through intensified research. Technological development takes time, it takes imagination, and more importantly, it takes funding. Research must be moved from the laboratory to the pilot stage, and through demonstration projects before it can be employed commercially.

If we are to be ready by the mid-1990's to make coal the backbone of our future electric energy supply, we must embark now on intensive clean coal technology commercial demonstration.

The private sector cannot mount the needed programs alone. The funds simply are not available. Participation of the Federal Government with the private sector is essential in getting this job done. Without Federal funding, the commercial demonstrations of promising technologies and other important clean coal projects will be slowed down or be left undone entirely.

It is important that cost effective clean coal technologies be commercially viable by the mid-1990's to support the next generation of electric generating facilities. Availability, reliability and cost of electric energy are important to every sector of our economy. Electric energy powers our economy, and the control of cost of electric

energy to American industry can help in making domestic industry more competitive in the international marketplace, and that translates to jobs for American workers.

We cannot leave the job of clean coal technology research undone.

Now, the coalition recognizes the difficult choices faced by the Congress in attempting to narrow the budget deficit, but the sacrifice of research and development such as clean coal technology would be unfortunate indeed. Too often we heard that American industry, unlike foreign competitors, curtails R&D for short term expediency at the sacrifice of tomorrow's competitiveness. We as a nation simply can no longer accept that, and in this instance, Congress can assume a leadership role.

In its report to the Congress on emerging clean coal technologies dated May 1985, DOE took the position that government funding was not needed to transfer new technologies to the private sector and to assure their commercialization. However, a contrary view was expressed by the Energy Research Advisory Board, DOE's own panel of outside energy research experts. They found, the panel, that is, and I quote, "In most instances, the current policy of abandoning a development after proof of concept has been established will result in just that, abandonment."

And we agree with the Energy Research Advisory Board.

Clean coal technology research serves an important national interest, and we believe it deserves Federal participation through the demonstration project phase.

We look forward to your favorable consideration of clean coal technology funding.

I thank you for your attention, and I have a long statement which I would like to submit for the record.

[The prepared statement of Mr. Disbrow follows:]

STATEMENT OF MR. RICHARD E. DISBROW
ON BEHALF OF THE CLEAN COAL TECHNOLOGY COALITION

INTRODUCTION:

Mr. Chairman, Members of the Subcommittee, my name is Richard E. Disbrow. I am President of American Electric Power Company, Inc., a public utility holding company whose operating company subsidiaries provide electric energy to portions of seven states in the midwest. The AEP System is among the largest users of coal in the production of electric energy in this nation. Currently approximately 90% of all electric energy we produce is from coal-fired generation. As a function of economic levels, the System will burn between 40 and 45 million tons of coal annually. We are also miners of coal. In 1984, coal mining subsidiaries of the operating utilities produced 13.5 million tons of coal for use in our generating stations.

Our commitment to coal as a source of primary energy spans eight decades. Over that interval, through our research and development efforts and those of others, we have learned to burn coal more efficiently and, of late, have committed to the development and utilization of advanced coal cleaning at significant expense. Washed coal now represents the majority of our annual usage. But more must be done.

Coal represents a vast domestic energy resource; a resource which can play an expanding role in this nation's energy future if we can learn to use it in a more efficient and

environmentally acceptable manner. Coal affords us the opportunity to move toward energy independence. There are many promising prospects which must be carefully explored. But technological development takes both time and money to move from the laboratory through the pilot stage to the demonstration project before full-scale commercial implementation.

It is clearly in the national interest that clean coal technology be developed as rapidly as possible and a sharing of funding between the federal government and the private sector is essential to that effort. Without federal assistance, the spectrum of clean coal technology demonstrations will be narrowed and the development line toward commercial projects lengthened.

THE CLEAN COAL TECHNOLOGY COALITION:

I am appearing before your Subcommittee as a member of the Clean Coal Technology Coalition, an ad hoc group of utilities, equipment suppliers, coal companies and architect engineering and construction firms and the National Coal Association. I ask that the membership of our group, along with a copy of the Coalition's statement in support of the clean coal program, be included in the hearing record at the conclusion of my remarks.

The Clean Coal Technology Coalition was organized earlier this year to provide a means by which interested private and

public sector parties might communicate to Congress and the Administration a collective viewpoint in support of the clean coal technology development program. Thus, no matter what interest an individual company or state government might have in obtaining government assistance for a particular technology or project, we have joined together in the hope of demonstrating to Congress that varied private and public entities support the need for a federally-assisted clean coal technology development program. Our interest as a coalition is to promote the rapid implementation and funding of a program which we believe makes emminently good sense.

On behalf of the member companies, industry associations and state governments associated with the Clean Coal Technology Coalition, I want to thank you for this opportunity to comment on the need for the program. Also, as you requested, Mr. Chairman, I intend to comment on the Department of Energy's recently submitted report to the Congress which addresses those proposals and statements of interest that were submitted to the DOE last February as a result of a Department of Energy solicitation directed by provisions of Public Law 98-473.

We do not agree with the Department's conclusion that "Federal incentives will not accelerate commercialization of these [clean coal] technologies and may be counterproductive to their development." (See page 1-4 of the Report to Congress on

Emerging Clean Coal Technologies. May 1985.) The DOE states in the report that this conclusion was reached based upon "the Department's previous experiences with Federal incentives." According to the Department, most projects that have received Federal assistance in the past have not led to successful commercialization of new fossil technologies. We believe the Exxon Donor Solvent project, the Cool Water gasification/ combined cycle project and the TVA fluidized bed combustion project are examples of just the opposite conclusion. Federal government participation has accelerated development and will greatly assist the private sector participants in providing the experience required for near-term widespread application of this technology in utility settings.

Ironically, perhaps, on the same day that the Department transmitted its clean coal report to the Congress, the Energy Research Advisory Board (ERAB), DOE's own panel of outside energy research experts, adopted a report to the Secretary of Energy which states in part:

> "Within the clean use of coal area the overall DOE program is well dispersed and all major technological areas are covered in some way. However, the budget does not allow DOE to help with the transfer of the new technologies to the private sector and

to assure their commercialization. This is the result of basic policy which should be reconsidered.

In most instances, the current policy of abandoning a development after Proof of Concept has been established will result in just that, abandonment." (Page 19, emphasis added.)

The current DOE policy is to stop government involvement in technology development before the demonstration or process development stage (see Chart 1). The conclusions reached by the Department in the clean coal report simply reflect and restate this policy notwithstanding the contrary advice given by the government's own panel of outside experts.

Industry's response to the recent DOE solicitation, in which 175 submittals were made, including 159 submissions proposing specific emerging clean coal technology projects in 29 states, also evidences a view contrary to the DOE's conclusion. The private sector will proceed with, and not abandon, clean coal technology development if government support is provided to complement very substantial private sector cost-sharing. The willingness of industry to provide significant amounts of private funds, often equaling or exceeding fifty percent of the projected cost of the project, strongly evidences a commitment to projects and technologies.

Any lack of success in commercializing new fossil technologies with respect to prior DOE assisted technology development projects cannot and should not be solely attributed to DOE involvement as the Department's clean coal report suggests. If such a conclusion has validity, then the solution is to fashion a government/private sector partnership rather than to conclude that commercialization has been unsuccessful whenever the government gets involved. As the ERAB report suggests, the alternative is equally unappealing, that is, technologies will be abandoned if government assistance beyond research and development is not provided.

THE NEED FOR NEW COAL UTILIZATION TECHNOLOGIES:

The need to develop new coal utilization technologies is premised upon two related factors. First, new electrical generation, not currently planned or under construction, will be needed in the 1990's to replace aging facilities, to reduce dependence upon oil- and gas-fired power generation and to ensure that economic growth is not stymied for lack of adequate electrical generating capacity. Secondly, the continued or expanded use of coal will be dependent, in part, upon the development of new technologies which offer cost-effective means of producing electricity or providing energy for industrial use in an environmentally acceptable manner.

I. NEED FOR NEW ELECTRICAL CAPACITY

Projecting future electricity demand has been particularly difficult and controversial for many utility planners and outside analysts who have projected growth of electricity demand ranging from less than one percent to about five percent annually over the next 10 to 15 years. The Edison Electric Institute, recognizing these widely varying projections, states in its recently published report on nuclear power: "It is possible that the additional generating capacity needed by the year 2000 could be as little as a few million kilowatts and as much as 500 million kilowatts -- or about three quarters of today's installed capacity." (At page 17, Report of the Edison Electric Institute on Nuclear Power, February 1985.) These wide differences in projected future demand result, in part, from unknown factors about economic growth and the future use of electricity. Furthermore, other significant unknowns include possible additional environmental legislation and regulation which might impact the continued service of existing units, further nuclear deferments, oil supply interruptions, the yet-to-be-proven ability to concurrently increase both the availability and life of existing capacity and the success of further conservation, load management efforts and other demand-reducing programs.

There is general consensus that new capacity will be needed even though the rate of increased demand is not agreed upon. The electric utility industry through the projections of individual companies aggregated by the North American Electric Reliability Council is projecting growth in electricity demand of 2.5 percent annually through 1993.

According to the Edison Electric Institute:

> "With demand growth of 2.5 percent and a capacity margin of 20 percent, additional capacity is needed by 1992 and a total of 152 million kilowatts of new capacity or demand reductions will be needed by the year 2000. Of this need, 34 million kilowatts of capacity have been reported to North American Electric Reliability Council as planned but not under construction.
>
> In the present economic and regulatory environment, some of the nuclear units now under construction may not be completed or permitted to operate. For example, if 8 million kilowatts of the capacity under construction are cancelled and if one third of the units over 40 years are retired, the capacity needed by the year 2000 would

total 192 million kilowatts with demand growth of 2.5 percent." (Report of the Edison Electric Institute on Nuclear Power, February 1985, at page 20.)

The EEI has concluded that "100 to 200 million kilowatts of new generating capacity will be needed -- in addition to units still under construction today -- before the year 2000." Attached to this statement are chart 2, which depicts U.S. electric generating capacity and peak demand between 1984 and 2000 and chart 3, which depicts U.S. electric generating capacity and peak demand with possible cancellations and retirements between 1984 and 2000. Each chart attempts to display how different projected growth scenarios will impact upon electricity capacity. If, for example, a demand growth rate of 2.5 percent is achieved then sometime in the early 1990's peak electricity demand is expected to exceed installed capacity and some new capacity above what is already planned will be required.

Current trends and the recent history of the utility industry strongly suggest that new capacity may not be built in time to meet increased demand. If, for example, the projected capacity needs of the mid-1990's are to be met with conventional generating units we believe that it takes from 9 to 10 years to permit, design, construct and place in service,

utilities must undertake those new power plants now. That construction is not being undertaken and, in fact, the electric utility industry is entering a period in which relatively little new generating capacity will be under construction and many companies have completed or will soon complete building programs. Further, many utilities, which only recently were forced to cancel or abandon the construction of large base load facilities, including conventional coal-fired power plants, are not now likely to undertake major new construction programs. Also, it is projected that new demand and, therefore, new capacity requirements for many utilities will come in much smaller increments which do not warrant construction of large scale conventional power plants. And, finally, because the growth of electricity demand has slowed considerably, so that electricity growth in proportion to the growth of the economy, any miscalculations by utility planners in projecting demand could result in excess capacity being built. The cost of such capacity cannot be easily recovered when there is no longer the periods of rapid growth which once characterized the utility industry and ensured that excess capacity would be quickly utilized. In fact, regulatory commissions have little sympathy toward allowing the recovery of investments for capacity built in excess of real demand and have, in some instances, forbidden the recovery of new, excess installed generation. These and other circumstances cause considerable uncertainty within the

electric utility industry and this uncertainty simply means that utility executives will be ever more cautious in adding capacity.

There appears, therefore, to be little impetus and even less time in which to address the electricity needs of the 1990's. If new clean coal technologies are to be utilized to meet expected capacity demands during the mid- to late 1990's, those technologies must be commercially demonstrated and available in the 1990 to 1993 time frame. It takes approximately 3 to 4 years to design and build a commercial demonstration and 2 years to conduct testing. Therefore, to be available in the early 1990's these clean coal technology demonstrations must be initiated in the 1985-1988 time frame. That time frame is already upon us. The next ten years are very important in both assuring future environmentally acceptable electricity supply and in controlling the costs of electricity. The commercial demonstration of clean coal technologies is at least one important option which the country would be wise to pursue in planning for ways to meet increased demand.

II. NEED TO DEVELOP COST-EFFECTIVE COAL UTILIZATION TECHNOLOGIES WHICH ENSURE CONTROL OF EMISSIONS

The important goal of protecting the environment and minimizing sulfur dioxide, nitrogen oxide and particulate emissions which result from the combustion of an inherently dirty fuel might be achieved in a number of ways. To date, industry has responded to regulatory controls by fuel switching, by pre-combustion coal cleaning, and by installing post-combustion pollution control devices. Conventional coal-fired power plants can comply with current and proposed environmental requirements, but the dollar costs are high. To put these costs in perspective, the cost to retrofit a flue gas desulfurization system to a 10-year-old power plant can exceed the original investment in the facility. Also, approximately 40 percent of the capital investment and 30 percent of the total cost of power for new, coal-fired power plants are related to environmental control. Finally, the use of flue gas desulfurization technology and other pollution control devices has a major impact on the efficiency and reliability of coal-fired power plants.

As the demand for coal-fired power production increases, the current requirements for emission limitations will continue or these emission limits might be made more stringent by new legislation or regulation. The resulting costs associated with

protection of the environment are a large and growing percentage of the cost of each kilowatt generated. It is important to understand that if the public demands even more stringent requirements for greater protection of the environment, the cost of compliance will take utility dollars away from clean coal technology development projects. For example, the Electric Power Research Institute has testified before the Congress that proposed acid rain control legislation that would require retrofitting flue gas desulfurization equipment on up to 100,000 megawatts of existing power plants burning high sulfur coal would cost approximately $200 billion over the remaining life of the plants in question. If these requirements were imposed, utilities would have no choice but to expend limited funds to comply with new regulations.

Another option to assuring protection of the environment besides simply promulgating additional regulations is to encourage the timely development of clean coal technologies. These new coal utilization technologies, besides assuring compliance with emission controls, also promise more cost-effective generation of electricity from a greater variety of coal resources. An opportunity for the timely development of these technologies should be provided.

Much has been written about the development and potential of new coal utilization technologies. Charts 4, 5 and 6, which

are attached to this testimony, attempt to describe the variety of technological options which are currently being pursued. These emission control options range from improved physical coal cleaning to furnace sorbent injection (e.g. LIMB), improved methods of combustion and advanced scrubbing technologies. Importantly, these technologies promise very significant improvements in the control of emissions from the use of coal. Chart 6 attempts to depict the possible advances in emission control likely to result from development of these various technologies. Further, a number of these clean coal technologies offer control of both sulfur dioxide and nitrogen oxide emissions, shorter construction lead times, improved fuel conversion efficiency, an ability to burn a wider variety of coals and the opportunity to construct power plants in modules which better match capacity additions to anticipated increased demand.

Pending legislation calling for emission reductions from existing power plants make the problem of timely development of clean coal technologies even more acute. Compliance dates between 1990 and 1995 require that new retrofit technologies be available for use in existing plants in the 1987-1990 time frame. Given this time frame, the commercial demonstration of technologies which can be used in retrofitting existing plants must be conducted over the next three years. Otherwise, this option for compliance might not be available.

It should be emphasized that no single clean coal technology is now thought to satisfy the variety of existing or projected coal-fired utility or industrial power generation requirements. All of those technology options which are mature and ready for commercial-scale demonstration should be considered likely candidates for the clean coal technology development program.

FACTORS WHICH INHIBIT PRIVATE SECTOR DEVELOPMENT OF CLEAN COAL TECHNOLOGIES:

The principal user industry of new clean coal technologies will be the electric utility industry. This industry is constrained in the amount of effort that can be directed toward large-scale, high-risk demonstration projects. This constraint is principally a function of the fact that the utility industry does not operate in a free marketplace. Return on an electric utility's investment is governed by public utility commissions that are generally charged with the task of minimizing ratepayer costs; risks undertaken by utilities in clean coal technology development will not necessarily be reflected in allowed profits or rewards. Indeed, if failure occurs, the burden may be placed primarily upon the shareholders of a utility and not the ratepayers. At a minimum, the costs involved in constructing a clean coal project, unless somehow characterized as research and development, must be carried by

the utility until that time when the plant is placed into service. This burden of carrying construction costs when added to the prospect that the facility might not be reliably placed into service at all creates too great a financial exposure for many utilities.

Furthermore, many utilities still face severe financial problems and cannot even raise capital funds for improvement or expansion of existing or new conventional electric power generation. This circumstance makes funding high risk clean coal technology development projects even more difficult.

Coal companies and utility equipment suppliers are also not able to bear the burden alone of significant investments in new technology development. Given the possibility that the domestic power generation market may be very limited for some time to come, such entities are reluctant to contribute substantial dollars to the costly demonstration of new clean coal technologies when the returns on their investments may be very limited.

A final factor which inhibits private sector development of new clean coal technologies is that once the demonstration stage of technology development is reached, enormous expenditures for engineering, construction, manufacturing, capital formation and operation are required. A new, "greenfields" clean coal technology project may require 5 to 6

years to design and construct and test. The exposure to project participants during the construction and demonstration phase which may result from changes in government policy or any number of other unanticipated occurrences can be so great as to result in utilities and other interested parties simply refusing to take significant risks. In addition, major modifications to the technology may be required after start-up, thus necessitating the expenditure of additional capital.

The Clean Coal Technology Coalition agrees with the DOE that the private marketplace should be responsible for the widespread commercialization of new clean coal technologies. However, the normal cycle of development which generally provides the private sector with sufficient time to commercialize a technology has been significantly disrupted. The private marketplace is currently faced with a dramatically changing picture in which the supply of electricity, now in surplus, may soon be outstripped by demand. Further regulations or new legislation may require costly modifications to existing facilities or more costly generation from any newly-constructed conventional power plants.

These changes, some of which may be imposed by government, necessitate a program of parallel government assistance like that envisioned by the clean coal program so as to assure timely development of technologies which may prove useful in

cost effectively addressing these changes. Thus, in order to accelerate the commercialization of clean coal technologies and, in some instances, to ensure that the technology is not abandoned after the research and development stage, some sharing of the costs by the federal government is highly desirable. For its part the private sector is willing to provide very significant private monies toward the demonstration of new, high risk technologies. The federal government is being asked to participate with the private sector in the commercial demonstration phase by also sharing a portion of the costs of new technology development.

THE ROLE OF THE FEDERAL GOVERNMENT IN THE DEVELOPMENT OF CLEAN COAL TECHNOLOGIES:

The clean coal technology development program envisions a partnership between the federal government and the private sector. This relationship is justified if the public receives benefits for the public funds sought to be expended.

Although it is possible that some technologies which could be supported by the clean coal program may never be commercialized, the fact that the private sector will be required to provide a large portion of the funds for a project increases the likelihood that early commercialization will occur. Therefore, an important public benefit is that this clean coal program is designed to provide the greatest

assurance that these technologies, once demonstrated with the assistance of public funds, are likely to then be used in widespread near term commercial applications.

Accelerated commercial demonstration is also very important if the Nation is to receive the benefit of new technologies when the need for new capacity arises in the 1990's. Early and widespread application of new coal utilization technologies which are less costly than current alternatives, which can be constructed and brought on line more quickly than current alternatives and which can be constructed in smaller -- even modular -- units to more nearly meet current demand requirements, are all benefits to be received by the public from successful implementation of the program. Also, technologies that might enable retrofitting of existing power plants to reduce or better control emissions and/or increase efficiency could also be demonstrated under the clean coal program.

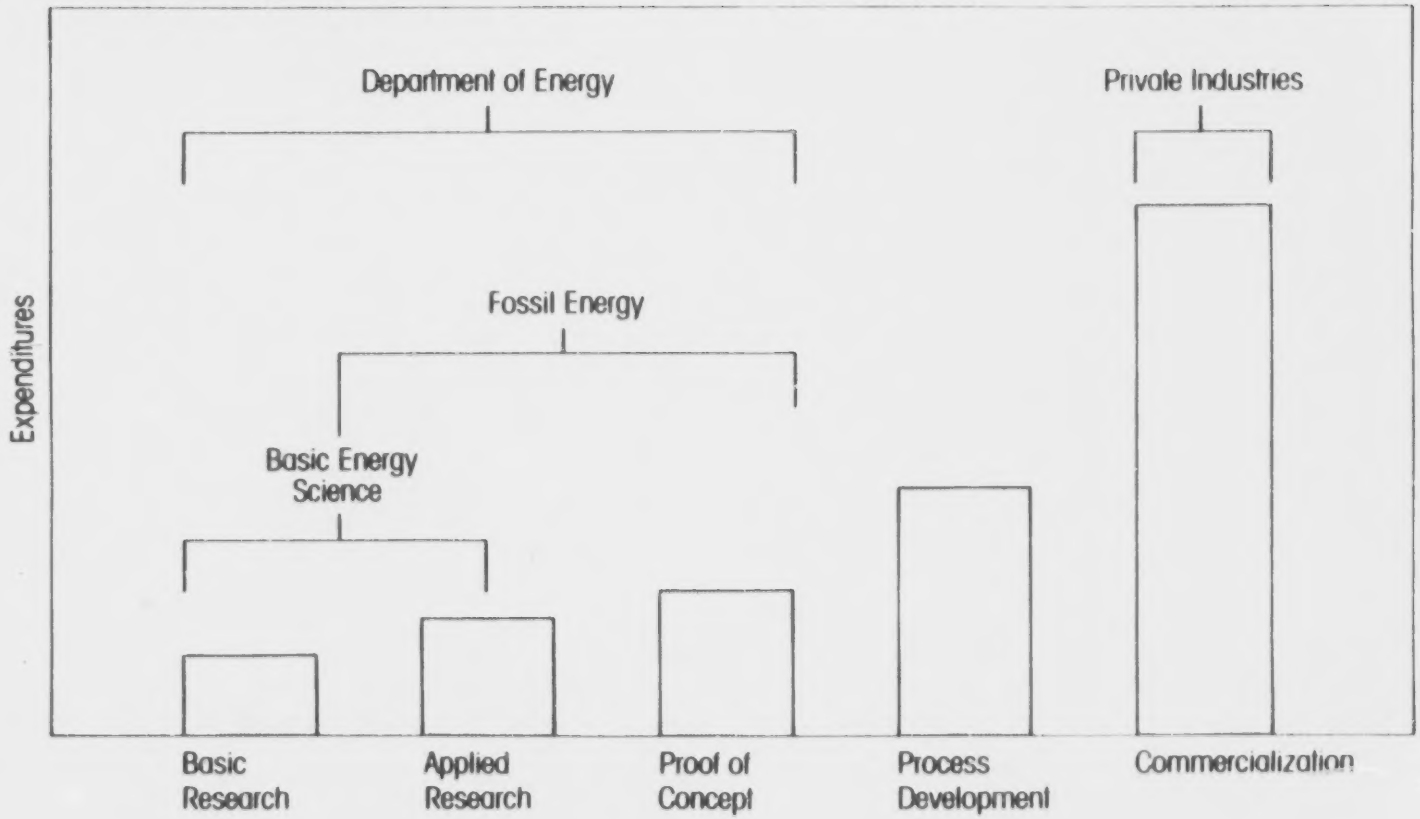
The public benefits of early commercialization of clean coal technologies, which include the promise of better environmental protection, more cost-effective production of electricity and more efficient use of our coal resources, are compelling reasons to implement the clean coal technology program rapidly.

CONCLUSION

Mr. Chairman, on behalf of the Coalition, we applaud your interest and leadership in this important program. We have an opportunity to create a unique partnership between the government and the private sector. The marketplace has identified the technologies to be commercialized; the private sector is ready to commit very substantial funds to these projects; and our members are willing to put their projects into the competitive arena.

From the point of view of the Clean Coal Technology Coalition, we would encourage rapid implementation and sufficient first-year funding to ensure that industry will aggressively participate in this program.

CHART 1
Technology Development Path



The Technology Development Path

These Steps Are Defined Briefly as Follows

Basic Research:

Studies Directed Towards Development of Fundamental Scientific Knowledge Leading to the Definition of New Energy R&D Concepts;

Applied Research:

Activities to Resolve Broad Engineering and Physical Science Problems in Specific Fossil Technologies and Related Areas; However Practical Utility May Not Be Proven At This Stage;

Proof of Concept:

Development to Resolve Specific Problems to Determine the Technical and Environmental Feasibility of the Integrated Process. Data is Generated to Evaluate Critical Scale-Up Parameters, Characterize Sub-Systems, Processes, and Products, and to Permit Preliminary Economic Projections to be Made;

Process Development:

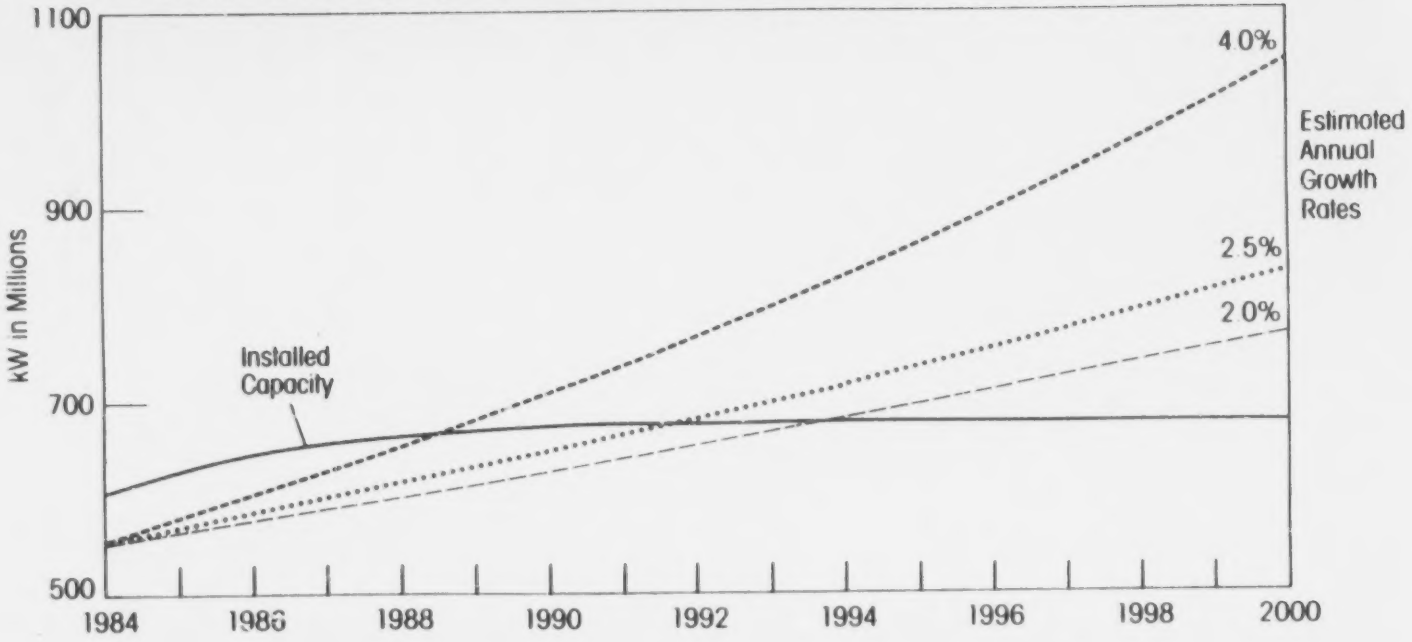
Increasingly Larger Scale Engineering Design, Construction and Operation of Energy Systems With the Objective of Reducing Technical Risks and Improving the Process Operability, Reliability, Economics, and Environmental Impact;

Commercialization:

Wide Variety of Efforts to Eliminate Technical, Economic and Institutional Barriers Required for Acceptance of a New Energy Technology into the Marketplace.

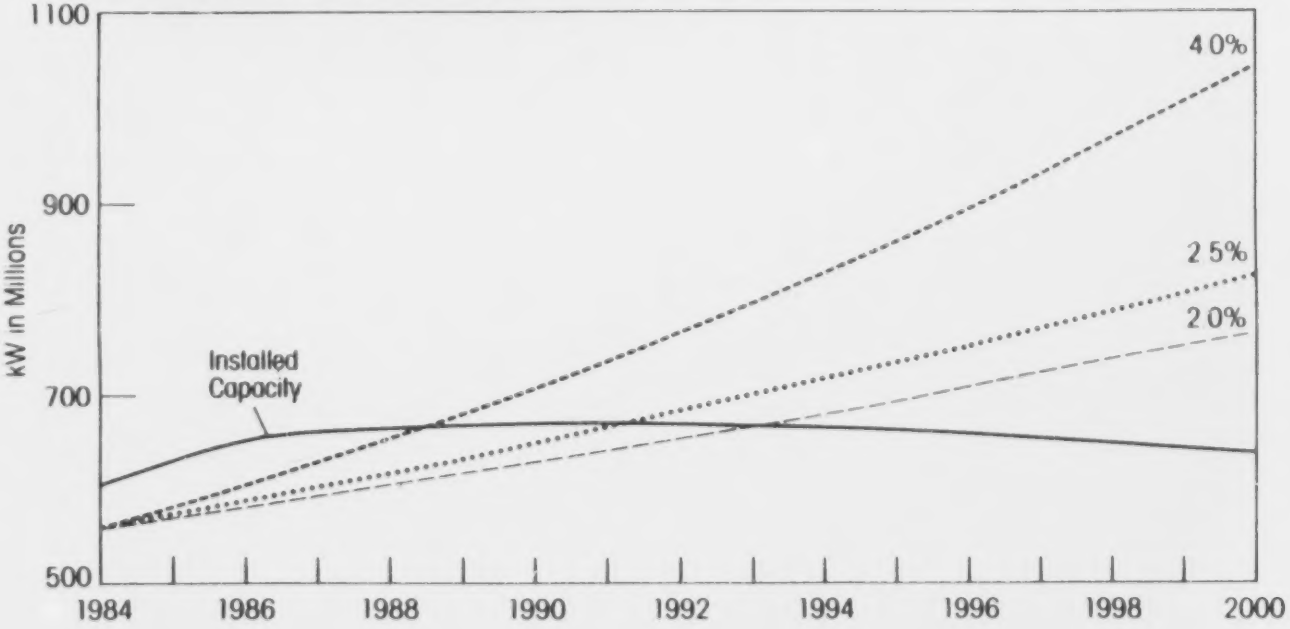
CHART 2

U.S. Electric Generating Capacity and Peak Demand, 1984-2000



Note: Peak demand at stated growth rates with 20% capacity margin needed for dependable supply. Includes existing capacity and capacity under construction less retirements of 15 million kilowatts through 1993 as reported to NERC.

CHART 3
U.S. Electric Generating Capacity and Peak Demand With Possible Cancellations and Retirements 1984-2000



Note Peak demand at stated growth rates with 20% capacity margin needed for dependable supply Includes existing capacity less retirements reported to NERC and assumed retirements after 1993, and capacity under construction less assumed cancellations

CHART 4
Coal Utilization

Opportunities for SOx /NOx Control

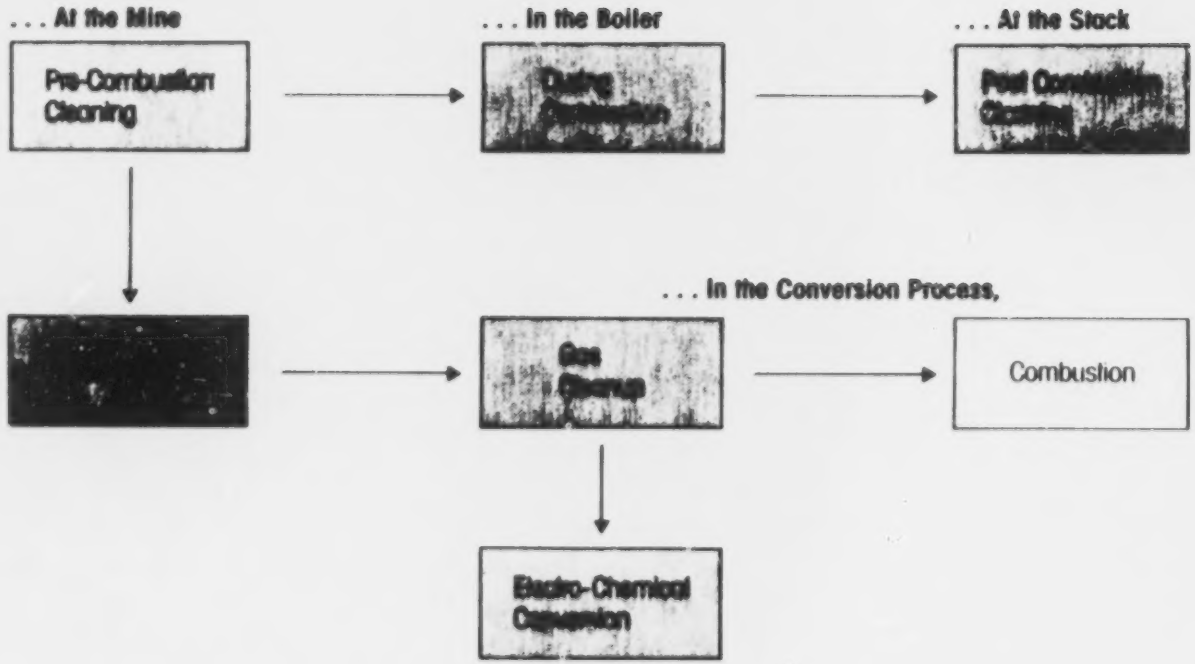
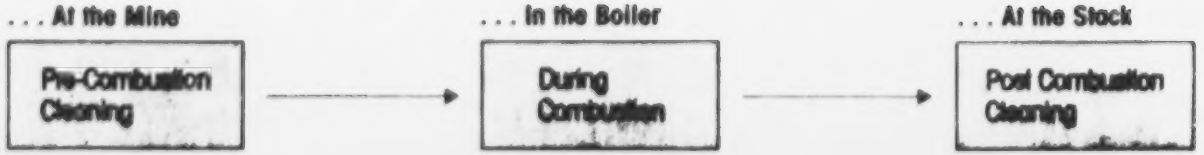


CHART 5
Coal Utilization

Opportunities for SOx /NOx Control



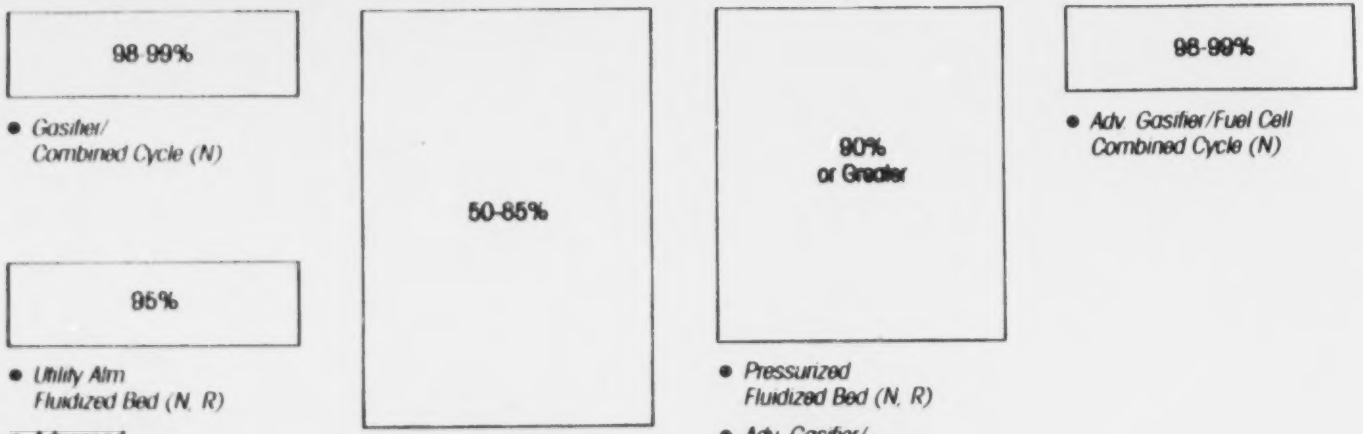
- Fine Grinding
- Dewatering (Low rank coals)
- Physical Cleaning and/or
- Chemical Cleaning

- Reconstitution
- Atmospheric Fluidized Bed
- Pressurized Fluidized Bed
- Low-NOx Combustors
- Slagging Combustors

- Furnace Sorbent Injection Technologies
- Flue Gas Desulfurization (Scrubbers)
- Advanced SOx /NOx Scrubbing

(Integrated Gasification Combined Cycle and Magnetohydrodynamics offer similar SOx /NOx control opportunities with differing techniques)

CHART 6
Emerging Technologies for SO_2/NOx Removal Potential


98-99%
• Gasifier/ Combined Cycle (N)
95%
• Utility Atm Fluidized Bed (N, R)
• Advanced Scrubbing (N, R)
50-85%
• Furnace Sorbent Injection Technologies (R)
• Retrofittable Partial Scrubbing (R)
• Retrofittable Partial SOx/NOx Scrubbing (R)
• Advanced Coal Cleaning (R)
90% or Greater
• Pressurized Fluidized Bed (N, R)
• Adv. Gasifier/ Combined Cycle (N)
• Gasifier/Fuel Cell Combined Cycle (N)
• Advanced SOx/NOx Scrubbing (N, R)
98-99%
• Adv. Gasifier/Fuel Cell Combined Cycle (N)
Symbols
Sulfur Removal Only
Sulfur and Nitrogen Removal
N—New Plant
R—Retrofit

CLEAN COAL TECHNOLOGY COALITION

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Co-Chairs:
The Signal Companies
American Electric Power

Statement of Support for the Clean Coal Program

The Clean Coal Technology Coalition supports the timely implementation and funding of a clean coal program which will result in the demonstration of technologies that use coal in an environmentally acceptable manner, at reasonable cost and which will operate reliably in utility systems and in large industrial applications.

Clean coal technologies must be demonstrated at or near commercial scale before they will have the confidence of the electric utilities industry and the agencies which regulate it. Most of these emerging technologies are not yet sufficiently advanced to have gained this acceptance. A regulated utility acting alone is constrained in its ability to support new technologies. Current regulatory policies impede the incorporation into the rate base of the research and development expenses associated with the commercialization of clean coal technologies. This requires utility companies to shoulder significant financial burdens. The Clean Coal Technology Reserve created by Congress in Public Law 98-473 would provide the stimulus necessary to assure the earliest practicable commercial availability of these emerging technologies.

The private industry/government partnership created by the Clean Coal Program is the least costly and most effective course the United States can pursue to ensure environmentally and economically acceptable use of our most abundant fossil energy resource. Furthermore, successful commercialization of clean coal technologies will significantly advance the national goals of utilizing this immense domestic energy resource in an environmentally acceptable manner, while providing electric utility customers and industrial users of coal with a more secure energy supply at reasonable prices.

CLEAN COAL TECHNOLOGY COALITION
Membership - May 14, 1985

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Winchester Coals, Inc.
1210 Smith Street
Charleston, West Virginia 25301

Senator WARNER. On behalf of the committee and its chairman, I thank you personally for venturing to the Nation's capital and providing this valuable testimony.

Mr. DISBROW. Thank you.

Senator WARNER. Now, Mr. Webb.

STATEMENT OF DAVID O. WEBB, SENIOR VICE PRESIDENT, POLICY AND REGULATORY AFFAIRS, GAS RESEARCH INSTITUTE

Mr. WEBB. Thank you, Mr. Chairman.

I am David Webb with the Gas Research Institute.

I appreciate the opportunity to appear before you today to discuss GRI's views and recommendations on the clean coal technologies initiative. I think it is particularly encouraging that over 175 private sector firms responded to the Department of Energy's request for statements of interest. This response is amazing when you consider the DOE made it extremely clear in its announcement that no funds are currently available, and furthermore, that DOE does not intend to request funds to start any of the proposed projects.

Though private sector response clearly indicates a need for Federal funding to accelerate research for and demonstration of emerging clean coal technology. GRI fully supports funding being made available to DOE for cofunding of these demonstrations with industry. Emphasis should be placed on near term applications that use natural gas in combination with other fuels for flue gas cleanup and longer term, for coal gasification applications that would provide one of the most cost-effective methods to clean up our vast coal resources.

A report to DOE—a report from DOE to Congress on emerging clean coal technologies indicates that the largest number of responses were in the four technology areas that could have the most near-term impact. These technologies, flue gas cleanup, surface coal gasification, fluidized bed combustion, and coal preparation, are all at a stage of development where the next logical step is field demonstration. Since these four technologies were proposed by over 70 percent of the private sectors firms that responded and recommended a specific process, their demonstration and cofunded field tests should receive immediate attention and top priority.

Also, the DOE report indicated that over 90 percent of the submissions requested direct cost sharing rather than other forms of financial assistance. This convincingly indicates that direct Federal support through cofunding is the required incentive.

The ERAB report which has been discussed earlier today emphasized two important policy factors that I would like to briefly touch on: First, the diversity of coal-use situations and the site-specific problems with the technologies indicate that no one general technology or solution will be presented. This means that multiple field demonstrations are required.

Second, the draft ERAB report also noted DOE policy has recently excluded work beyond the proof of concept stage. This policy limits timely commercialization of new technologies, and a revision of this policy is recommended.

Mr. Chairman, Federal policy has long overlooked the significant role natural gas can play in helping the Nation use coal in an environmentally accepted manner. Therefore, it is significant and encouraging to GRI that several of the responses to demonstrate flue gas cleanup included the use of gas for both NO_x control and to assist in SO_2 control.

Natural gas is our Nation's cleanest fuel. Used selectively, either alone or with other more polluting fuels, relatively small quantities of natural gas can contribute significantly to protecting our air quality in the least costly manner.

Therefore, using gas as part of the overall approach to controlling pollution emissions during coal combustion should become one element of this program and part of national energy policy.

One other policy issue I would like to touch on, in evaluating the urgency of moving forward with clean coal technology demonstrations, it is informative to briefly recap the changes in energy policy that have occurred since the Energy Security Act passed in June of 1980. With the Iranian crisis in 1979, the United States was faced for the second time in 6 years with skyrocketing crude oil prices. Responding to the need to develop domestic sources of energy, Congress created the Synthetic Fuel Corporation to provide financial assistance to the private sector to undertake commercial synthetic fuels projects.

At the same time, DOE had a very large and aggressive fossil fuels demonstration program that was strongly supported by Congress. It was assumed that technology developed in these DOE programs, including clean-coal technologies, would be available to draw upon for commercial demonstrations, especially in phase 2 of the SFC program.

However, today the DOE fossil fuels demonstration program has been terminated. DOE has limited their research to long-term proof of concept. The result is a serious technology gap. Yet at the same time, DOE has continued to insist that research demonstrations such as these being proposed here are the role of the private sector and will be guided by market forces.

However, as already noted today by Senators Ford and Rockefeller, in some industries market forces are not sufficient. Many of the markets in which energy is sold are not free. As ERAB noted in its 1982 report to DOE on establishing energy R&D priorities—and I would like to quote:

> A little over half our primary energy finds its way to consumers through the electric and gas utilities, and these utilities are regulated, price controlled industries selling their products not at free market prices but at controlled prices. Both these regulated industries have weak incentives to spend on R&D. If successful, the benefits go to the rate payer. If unsuccessful, the expenditures may be disallowed as imprudent. In this environment the utility sector simply does not have the incentives to make the necessary research investments to adequately demonstrate these urgently needed cleancoal technologies.

GRI and EPA are currently cofunding research that examines control of NO_x and SO_x emissions from coal combustion, incorporating two developing gas combustion technologies as part of an integrated flue gas cleanup system. These look extremely promising, and their testing and demonstration which would require about $30

million over 5 to 7 years, should be part of the Government program cofunded with industry.

After reviewing the DOE report, the ERAB report, and the current status of technology, I would like to make the following recommendations.

No. 1, Congress recognize that DOE has a leading role in demonstrating new clean-coal technologies, and appropriate funds in fiscal year 1986 to initiate a limited number of the proposed demonstrations.

No. 2, priority should be given to the four near-term technologies proposed in over 70 percent of the private industry responses. These technologies are flue gas cleanup, coal gasification, including combined cycle, fluidized bed combustion and coal preparation.

Three, use of natural gas in the demonstration of flue gas cleanup should be assigned a top priority.

Four, the private sector, and most especially, technology users, should be responsible for providing a significant share of the costs through cofunding.

Five, the executive branch should leave day-to-day management of the project to the industrial partner.

Six, priority should be given to proposals that reduce total cost by using existing facilities. It has been estimated in some DOE studies that you could do these demonstrations at existing facilities for approximately one-third the cost of building a stand alone demonstration plant.

And finally, Mr. Chairman, we think it would be wise if the Synthetic Fuel Corporation would be encouraged to make provisions in its financial assistance package of these commercial synfuel plants to require the capability for testing advanced technologies at the plant site in the future. This again would give us a test bed for testing these advanced technologies at a lot less cost than building stand alone plants.

In conclusion, the current Federal energy research policy has created a technolgy gap. Congress can take a bold step toward closing this gap by appropriating funds in fiscal year 1986 for clean coal technology demonstration. A joint DOE-private sector program is needed now.

Mr. Chairman, that completes my summary. I would like to submit my entire statement for the record, please.

[The prepared statement of Mr. Webb follows:]

TESTIMONY OF DAVID O. WEBB
SENIOR VICE PRESIDENT, POLICY AND REGULATORY AFFAIRS
GAS RESEARCH INSTITUTE
BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON ENERGY AND NATURAL RESOURCES
U.S. SENATE
MAY 16, 1985

I appreciate the opportunity to appear before you today to discuss the Gas Research Institute's views and recommendations on the clean-coal technologies initiative specified in Section 321 of the Department of the Interior and Related Agencies Appropriations Act for FY 1985 enacted by House Joint Resolution 648, Public Law 98-473. It is particularly encouraging that 175 private-sector firms responded to the Department of Energy's request for statements of interest. This response is amazing when you consider that DOE made it extremely clear in its announcement that no funds are currently available and, furthermore, that DOE does not intend to request funds to start any of the proposed projects. The private-sector response clearly indicates a need for federal funding to accelerate research for and demonstration of emerging clean-coal technologies. GRI fully supports funding being made available to DOE for clean-coal technology demonstrations, especially for near-term applications that use natural gas in combination with other technologies for flue-gas cleanup and for longer-term coal gasification applications that would provide one of the most cost-effective methods to clean up our vast coal resources. In the near-term, the use of gas in a reburn mode for nitrogen oxides (NO_x) reduction and as a transport medium for sorbent injection to reduce sulfur dioxide (SO_2) as an integral part of flue-gas cleanup in coal combustion systems offers the potential for early retrofit in many utility and large industrial boilers. These technologies should be given high priority in any demonstration program.

GRI is an independent, not-for-profit scientific research organization that plans, manages, and develops financing for a cooperative research and development program for the mutual benefit of the gas industry and its present and future customers. The R&D program is implemented through contracts with research organizations, engineering and other professional service firms, universities, energy companies, and manufacturers. Even though GRI is not a government contractor and does not accept federal funds, GRI cofunds and coordinates many of its research programs with DOE. Therefore, Congress's actions on the FY 1986 DOE budget have a direct impact on the gas industry's research program.

A review of the DOE report to Congress, Emerging Clean Coal Technologies dated May 1985 indicates the largest number of responses were in the four technology areas that could have the most near-term impact. These technologies--flue-gas cleanup, surface coal gasification, fluidized-bed combustion, and coal preparation--are all at a state of development where the next logical step is field demonstration. Particularly encouraging to GRI is that two of the technologies--flue-gas cleanup and coal gasification--recognize the role of natural gas in cleaning up our nation's coal. These applications of natural gas have tremendous potential. Since these four technologies were proposed by over 70 percent of the private-sector firms that responded and recommended a specific process, their demonstration in cofunded field tests should receive immediate attention and top priority.

Also, the DOE report noted that nearly all of the submissions requested direct cost-sharing rather than other forms of financial assistance. This cost-sharing is necessary due to the significant risks associated with the technologies; the current softening of world oil prices; the inability for many utilities to recover capital costs due to the novelty of the technologies; a lack of evidence that the technologies are practical, useful, and economical; and the need to accelerate the commercialization of the technology through demonstrations so the technologies are available to industry in the early 1990s. These factors convincingly indicate that direct federal support through cofunding is required to accelerate the commercialization of clean-coal technology. Without this federal support, many of these technologies will not be demonstrated. Others eventually will be demonstrated by the private sector but not in time to meet the nation's need for future energy demands.

Other factors emphasized by the draft Energy Research Advisory Board (ERAB) report to DOE on clean-coal technologies that must be recognized are that the number of coal-use situations is so large and diverse and the specific problems are so site-specific that no generally applicable technology or solution can be presented. This is particularly true for retrofit applications which represent the overwhelming majority of the market. The draft ERAB report also noted, "DOE policy has recently excluded work beyond the proof-of-concept stage; this policy limits timely commercialization of new technologies, and a revision of this policy is recommended." Therefore, the use of federal funds to cofund the demonstration of multiple technological approaches with industry is the most viable solution to using our coals cleanly.

ROLE OF GAS IN CLEAN-COAL TECHNOLOGIES

Federal policy has long overlooked the significant role natural gas can play in helping the nation use coal in an environmentally acceptable manner. It should be emphasized that several of the responses to demonstrate flue-gas cleanup include the use of gas for both NO_x control and to assist in SO_2 control. In fact, for near-term and many retrofit applications, gas used in combination with coal combustion systems is probably the best solution.

Natural gas is our nation's cleanest fossil fuel. Its combustion emits virtually no particulates, sulfur oxides, or reactive hydrocarbons, and it produces far lower emissions of nitrogen oxides and carbon monoxide per unit of energy than coal or oil. Used selectively, either alone or with other more polluting fuels, relatively small quantities of natural gas could contribute significantly to protecting our air quality in a least-cost manner. Given the size of the gas resource base and the economics of gas production, the competitive position of gas relative to other environmental control options should remain favorable. In addition, a million-mile pipeline and distribution network is already in place which extends to most potential select gas-use customers. Thus, cost-effective solutions to using coal cleanly are both possible and practical by using natural gas.

Gas can be used in one combustion unit to offset the emissions from dirtier fuels, such as coal, in another unit; it can be used for simultaneous combustion of gas and coal in a single combustor; and it can be used in flue-gas cleanup systems as a transport mechansim for sorbent injection to

reduce sulfur oxides (SO_x) and in a reburn mode to reduce NO_x. Therefore, using gas as part of the overall approach to controlling pollutant emissions during coal use should become one element of national energy policy.

FEDERAL ENERGY R&D FUNDING POLICY SHIFTS

It is important to review the shift in priority this Administration has assigned to energy R&D when examining the need for DOE support for clean-coal technology demonstrations. The dramatic decline in energy R&D funding is very evident when comparing the FY 1981 and 1986 requests after deleting the business-related functions. This decline is easily obscured since the Administration included $2.4 billion of weapons R&D and $685 million of general science activities in the FY 1986 energy R&D budget category. When these non-energy-specific items are removed from the energy R&D budget, in FY 1986 the Administration requested only 20 percent--or a $2.3 billion allocation--for energy R&D programs, while in FY 1981 it requested about 60 percent--or $5.9 billion, for energy R&D.

Another factor limiting technology demonstration and transfer to industry is that DOE has established a general policy of not funding research beyond proof of concept. This policy of leaving hardware development solely to industry sounds nice, but it hasn't worked. The result is a technology gap that is widening as DOE continually withdraws to long-term and basic research. The justification for intermediate-range energy applications R&D is as strong as ever. DOE must once again reemphasize energy R&D and establish technology development resulting in hardware projects and demonstrations as a focal point for fossil energy research.

DOE R&D AND DEFENSE PROGRAMS
($ Billions)

	FY 1981	FY 1986
Energy R&D	$ 5.922	$ 2.295
General Sciences	0.523	0.685
Department Management	0.362	0.299
Defense Programs	3.443	8.060
TOTAL	$10.250	$11.269

If national energy policy continues this trend of constant reduction in energy R&D spending and no federal support for technology demonstrations, we will soon find ourselves without technology for full development of our vast domestic fossil fuel resources.

U.S. ELECTRICITY OUTLOOK

In determining the most prudent federal role in supporting demonstrations of clean-coal technologies, it is critical to consider the extent to which the U.S. must rely on coal to meet its electric power generation demands between now and 2010. As a result of several major independent trends, the use of

coal in the U.S. is expected to continue to increase at a reasonably steady pace for most of the next 25 years. The two major influences of this trend are the continued high (compared to coal) price of oil and the reduced contribution of nuclear power. Both private and federal forecasts agree that the U.S. will continue to rely on fossil fuels for over 75 percent of its energy supplies during the next 25 years.

However, unless technology is developed and demonstrated to allow the U.S. to utilize its coal in an environmentally acceptable manner, the U.S. faces the possibility of shortages in electric generating capacity in the 1990s. Under any reasonable scenario of growth, electric consumption will increase. As stated by DOE Secretary Herrington in a speech on April 23, "Demand for electric power has continued to show a strong relationship with the growth of our economy." GRI's modeling efforts indicate future electric-use growth will be at a rate equal to approximately 85 percent of the rate of growth of the economy. Therefore, unless our economy is totally stagnant with resulting rapid increases in unemployment and misallocation of resources, electricity demand in the 1990s will continue to increase and will require the construction of new generating plants. While gas-fired combined-cycle power plants can meet some of the projected demand, if nuclear power does not make a quick resurgance to survive as a viable future U.S. energy option, coal is the major domestic energy option with sufficient long-term resources to fuel the majority of U.S. power plants. This scenario becomes especially convincing when you consider that the U.S. holds one-quarter of the world's known coal reserves, and electricity use, even with all of the conservation due to higher energy prices and economic downturns, has grown by approximately 30 percent since 1973.

The activation of the $750 million clean-coal technology fund to allow DOE to demonstrate clean-coal technologies in partnership with the private sector would be a valuable investment for securing our future energy needs under environmentally safe conditions.

A "TECHNOLOGY GAP"

In evaluating the urgency of moving forward with the clean-coal technology demonstrations, it is informative to briefly recap the changes in energy policy since the Energy Security Act in June 1980. With the Iranian crisis in 1979, the U.S. was faced, for the second time in six years, with skyrocketing crude oil prices. Responding to the need to develop domestic sources of energy, Congress created the Synthetic Fuels Corporation to provide financial assistance to the private sector to undertake commercial synthetic fuels projects. The Energy Security Act authorized up to $88 billion for synthetic fuels development, of which $20 billion was appropriated in 1980 for Phase I.

At the same time, DOE had a large and very aggressive fossil fuels demonstration program. It was assumed that technology developed in these DOE programs would be available for the SFC to draw upon for commercial demonstrations, especially in Phase II. However, today the DOE fossil fuels demonstration program has been terminated.

The result is a serious technology gap between long-term generic research and commercialization. DOE's current R&D policy does not fund "process" development or pilot plant activities. However, the process development stage is perhaps the most crucial stage in the development of a new technology. It

is during this stage that a good technical idea is turned into a process with commercial potential. The construction and operation of a process development unit (PDU) leading to demonstration of the technology at pilot or pioneer plant scale are both essential steps in advancing technology. Neither step can be skipped. Yet DOE has continued to insist these research activities are the role of the private sector and will be guided by market forces.

However, in some industries, market forces are not sufficient. Many of the markets in which energy is sold are not "free." As ERAB noted in its 1982 report to DOE Energy R&D Priorities:

> A little over half our primary energy finds its way to consumers through the electric and gas utilities, and these utilities are regulated, price-controlled industries selling their products not at free market prices, but at controlled prices. Both these regulated industries have weak incentives to spend on R&D. If successful, the benefits go to ratepayers; if unsuccessful, the expenditure may be disallowed as "imprudent." A strong R&D response to price signals requires both motivation and capability. In many cases the capability is simply lacking.

If there is one thing the energy crisis of the past 12 years has taught us, it is that uncertainty is the only certainty. Long-term energy forecasts have proven to be consistently wrong. We cannot make policy assumptions with any confidence regarding the direction of energy demand, production, and prices. The real interest rates are double the historical experience, and the cost of capital for construction is high. Also, it must be recognized that the economics of many emerging clean-coal technologies are driven by the price of world oil, and this price is not based on production costs but is established by a cartel. In other words, the typical utility executive must make major energy decisions in a very unstable and uncertain operating environment.

In this environment, the utility sector simply does not have the incentives to make the necessary research investments to adequately demonstrate urgently needed clean-coal technologies. Therefore, the DOE policy has created a serious technology gap. The use of the clean-coal technology reserve to give DOE the resources to cofund these demonstrations with private industry is needed to close this gap.

Two gas-related technologies that can make a major contribution to using our nation's coal cleanly are coal gasification and flue-gas cleanup using gas-enhanced dry sorbent injection and reburn. Both require federal support for field demonstrations to close the "technology gap."

Coal Gasification

The establishment of a commercial coal gasification industry depends not only on the development of technically and economically viable coal conversion processes, but also on the extent to which those processes are compatible with the environment. New technologies are required to meet the nation's increasingly stringent environmental standards. Advanced coal gasification

technologies, with the potential for significant technical, economic, and environmental improvements compared to the commercially available technology, have emerged from the extensive R&D programs that have been supported by the federal government, by GRI, and by other organizations.

In response to the DOE Office of Fossil Energy solicitation for statements of interest for projects related to development of emerging clean-coal technologies, GRI submitted a statement recommending a coal gasification test facility at an existing host site. This project would result in the large-scale validation of advanced coal gasification processes for combined-cycle power applications, for producing pipeline-quality gas from coal, for gas cleanup and methanation, and for testing components and instrumentation.

For these advanced technologies for producing gas from coal (whether for power generation or pipeline-quality gas) to receive adequate consideration as a supplemental energy option, engineering performance data must be available from commercial-size or near-commercial-size systems in the mid-1990s. This will permit the reliable definition of capital requirements and end-product gas costs under conditions where the technical risks associated with the scale-up of the advanced technologies have been reduced to an acceptable level.

GRI is proposing to place a commercial-size or near-commercial-size advanced coal gasification process in an industrial environment where existing supporting systems and utilities are available and where the gasifier products could be utilized in the industrial operation. The gasifier should be oxygen-blown and operate at a pressure of 450 psi to 500 psi in order to provide data relevant to gas production. The program should be structured to accommodate the integrated slip-stream testing of the advanced downstream processing components that would be used to upgrade the gasifier products to a pipeline quality gas.

In 1984, at the request of the Congress, the U.S. Department of Energy conducted a preliminary study to examine the feasibility of installing and operating a semi-works, fluid-bed gasifier at the Great Plains coal gasification plant. The study was prompted by the recognition of a need to develop engineering data at a large scale for the advanced gasification technology that was under development in the U.S. and the existence of a large coal gasification plant infrastructure that could help defray the costs associated with developing the required system performance data. In addition to providing detailed technical data on gasifier operation and environmental interactions, substantial experience would be gained in operating commercial-size units based on the fluid-bed, ash-agglomerating technology.

The DOE study concluded that the concept of continuing the development of advanced fluid-bed coal gasification technology at the semi-works (600- to 1,000-tons-per-day) scale at the Great Plains coal gasification plant was feasible and had merit. The developers of the gasifier technologies that might be candidates for continued development at the semi-works scale at the gasification facility also supported this approach to advanced gasifier technology development.

The study considered a test program that would be more comprehensive than just an advanced gasifier activity and would provide for the testing additional gas processing components. Such components could include advanced downstream processing systems designed for the production of pipeline-quality gas and systems for integration with advanced electric power generation systems, i.e., hot gas cleanup, combustion turbines, etc.)

It is estimated that the design and construction of a 1,000-ton-per-day unit, and the necessary modifications to the existing facility would cost approximately $80 million and would have attendant annual operating costs of approximately $12 million. Assuming six years of operation, the total project cost would be about $150 million. A government/industry 50-50 cofunded project is appropriate at this time because short- and mid-term uncertainties of energy supply make it impossible to identify sufficient short-term incentives that justify capital expenditures for technologies where technical risks have not been demonstrated to be low.

No current commercial system has been satisfactorily demonstrated for high-sulfur caking coals, which are predominantly found in the eastern parts of the U.S. Some advanced concepts, however, have emerged from the extensive R&D efforts and appear to offer the potential for significant improvements over the technology that is commercially available for converting eastern coal to gas. These improvements are in the form of increased flexibility, lower capital costs, lower operating costs, reduced end-product gas costs, and reduced environmental impacts.

GRI's proposed coal gasification test facility project has the following principal objectives:

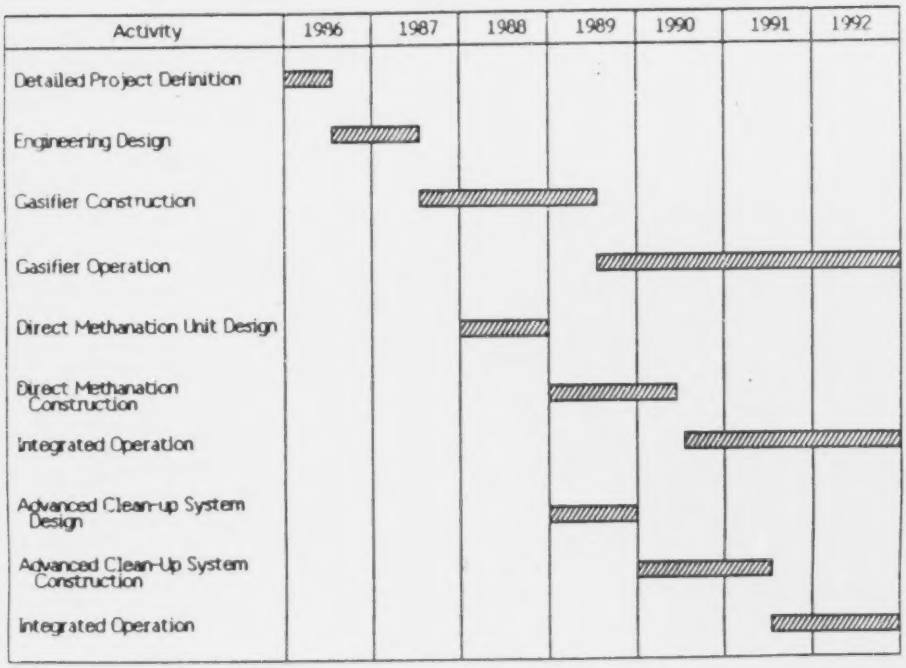
1. To demonstrate that the emerging coal gasification technologies have direct application to the production of pipeline-quality gas from eastern coal and offer significant technical, environmental, and economic advantages over the commercially available state-of-the-art technology.

2. To validate the performance characteristics of the emerging coal gasification technologies at a scale that will provide the heat balance, material balance, environmental data, and operational data needed to develop reliable cost estimates for future coal-to-gas plants based on these technologies.

3. To demonstrate the integrated performance of advanced gasifier technology and advanced downstream processing technology such that commercial systems could be constructed to maximize the technical, economic, and environmental advantages of these technologies.

Federal cofunding of this advanced coal gasification test facility with the private sector through the use of funds from the clean-coal technology reserve would be a cost-effective and prudent investment in the U.S. energy future. This should be assigned a high priority in any clean-coal technology program.

Project Schedule: Large Scale Demonstration- Emerging SNG Technology



Gas-Enhanced Dry Sorbent Injection and Reburn

Concern over acid precipitation and anticipated acid deposition legislation has created an incentive for government and industry to develop more cost-effective technologies to control both sulfur and nitrogen oxides from coal and oil combustion, particularly utility and large industrial boilers.

GRI and the U.S. Environmental Protection Agency are currently cofunding the Energy and Environmental Research Corporation (EERC) of Irvine, California, to develop dry sorbent injection technology combined with combustion modification techniques to control SO_x and NO_x emissions from coal and oil combustion. GRI's portion of this study is to examine control of NO_x and SO_x emissions from coal combustion by incorporating two developing gas combustion technologies which can be applied individually or as an integrated system.

1. Reburn Technology. Use of natural gas as a reburning fuel to reduce NO_x emissions.

2. Sorbent Injection Technology. Use of natural gas to generate more reactive and higher capture efficiency of sorbents for enhanced SO_x reduction.

EPA provided $860,000 ($400,000 in FY 1983 and $460,000 in FY 1984) in coordinated funding for the project via their existing reburn/sorbent injection contract with EERC. GRI's project ($937,900), which began in April 1984, expands EPA's original focus on coal-fired reburning/sorbent injection at EERC to include an evaluation of the additional benefits (e.g., cost reduction, increased emissions control, etc.) obtainable from the use of gas.

Sulfur oxides can be controlled by removing sulfur from the fuel or sulfur oxides from the products of combustion. However, current methods such as scrubbers or coal cleaning generally are capital intensive with high operating and maintenance costs or do not provide the necessary degree of SO_x control. One of the more promising SO_x control strategies is to inject calcium-based sorbents into the combustion chamber and capture the sulfur prior to the boiler outlet. This process was investigated in the late 1960s and was abandoned because it could not achieve the desired SO_x control and also tended to create operational problems. Recently, there has been sufficient incentive to re-examine the limestone injection process (e.g., LIMB) as a cost-effective alternative that could approach FGD sulfur removal at a lower cost. The EPA's efforts in recent years have focused on the development of this technology for coal-fired boilers. GRI's program with EERC is to enhance the cost-effectiveness of this technology through the use of gas combustion technology. Gas appears to offer significant sorbent injection performance benefits because it can be used to more effectively control the conditions at which limestone sorbent is calcined and mixed with the coal combustion flue gases; it can avoid coal-ash/sorbent interaction problems that decrease sorbent surface area; and it can be used more effectively to optimize the temperature profile of the sulfation zone where sulfur capture occurs.

Nitrogen oxide emissions are also considered, although historically to a lesser extent, as a contributing factor to acid deposition. The attention to NO_x as an acid deposition processor is increasing as scientific evidence tends to indicate that both SO_x and NO_x are contributors. The formation of NO_x during the combustion of fossil fuels can be minimized by appropriate modification of the combustion mixing process.

Recently, the Japanese have been exploring a new NO_x control strategy which involves in-furnace NO_x reduction by downstream injection of gas. EPA is currently conducting research programs to evaluate the potential of this technique for application to U.S. boilers. The term "reburning" has been coined in the U.S. to refer to this process. Where using gas as the reburn fuel, it appears that this technology is capable of reducing NO_x by approximately 50 to 60 percent beyond the current NSPS level achievable with low-NO_x burners. The use of coal or oil as a reburning fuel may introduce operational problems because of poor carbon burnout resulting in a loss of efficiency as well as slagging in the platens or primary superheater region. The specific technical benefits of using gas as the reburning fuel are that gas can be applied without the combustion problems associated with coal-firing in upper boiler regions; gas allows lower exhaust NO_x emission levels to be achieved since it is nitrogen-free; and gas avoids the presence of molten ash in the superheater boiler region, thereby minimizing slagging and fouling problems.

The use of gas technologies could also have an application in those instances where oil-fired boilers are being converted to coal/water slurry mixtures. Combustion systems which burn coal water slurries efficiently in boilers designed for oil rely upon efficient fuel/air mixing, precisely those conditions which promote the formation of nitrogen oxides. Consequently, any conversion could result in a considerable increase in both SO_x and NO_x emissions. An additional problem associated with conversion to coal-water slurries is the need to derate the unit to prevent excessive erosion in the convective sections. Natural gas used as a reburning fuel with or without sorbent injection can help solve two problems--pollutant emissions and unit derating.

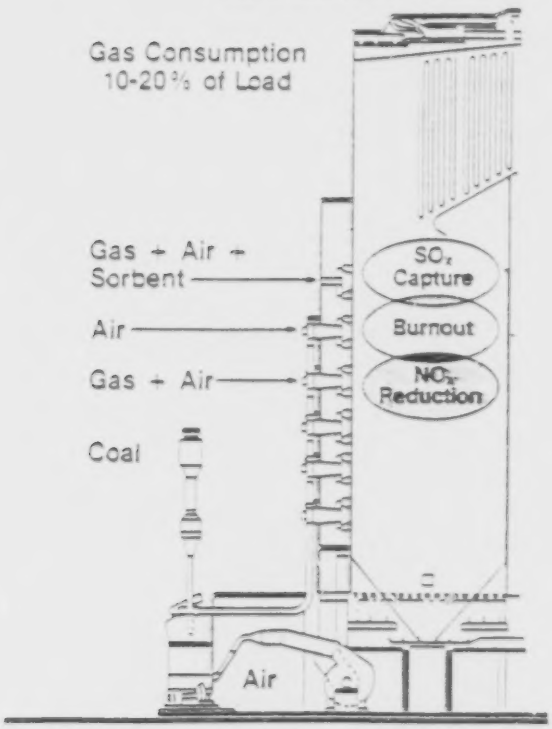
Potential benefits of gas use are both environmental and economic. The development of more cost-effective SO_x, NO_x and combined SO_x/NO_x control technologies using gas would lower energy costs and improve air quality. The economic benefits are broad-based and provide an alternative to high-cost flue-gas scrubbing technologies and increased ability to use the nation's natural resources along with a decreased dependency on imported oil. The environmental benefits would accrue by significantly reducing the quantity of pollutants emitted by coal or oil burning.

In conclusion, gas has the unique advantage of allowing the simultaneous application of reburn and sorbent injection technologies in the same boiler. Over the next five years, GRI plans to spend approximately $5 million to $6 million to support research and development of the reburn/sorbent injection technology for application to industrial and utility boilers. By using natural gas to enhance reburn/sorbent injection technology, GRI's goal is to increase the NO_x/SO_x capture performance of this technology to NO_x levels lower than attainable with low-NO_x burners and to attain SO_x levels approaching that of wet scrubbing but at a significantly lower cost. Different technology variations are being explored at both bench and pilot scales. The next step is to initiate full-scale testing of reburn technology starting in 1986. This testing should be performed using both an industrial and a utility boiler to demonstrate retrofit applications.

Multiple field tests of reburn/sorbent injection technology as an integral element of flue-gas cleanup are required as application techniques are likely

to vary significantly with boiler type (cyclone, pulverized coal, stoker, etc.) It is estimated that field testing of these two technologies will require an investment of approximately $25 million to $30 million dollars over the next five to seven years. Government cofunding to demonstrate the use of gas in reburn/sorbent injection technology as a central element of the clean-coal initiative is needed now.

GAS APPLICATIONS RESEARCH



Gas Enhanced Dry Sorbent Injection
Plus Gas Reburn -
SO_x/NO_x - Control

RECOMMENDATIONS

As a result of reviewing the DOE report, the draft ERAB report, and the current status of coal gasification and gas reburn and sorbent injection technology, I recommend the following:

1. Congress recognize that DOE has a leading role in demonstrating new clean-coal technologies.

2. Congress appropriate funds in FY 1986 to initiate a limited number of the proposed clean-coal technology demonstrations. Priority should be given to the four near-term technologies proposed in over 70 percent of the process-specific responses--flue-gas cleanup, coal gasification, fluidized-bed combustion, and coal preparation.

3. Use of natural gas in the demonstration of flue-gas cleanup should be assigned a top priority.

4. The private partner and technology users should be responsible for providing a significant portion of the construction and operation costs of the facility through cofunding.

5. The executive branch should leave the day-to-day management of the project to the industrial partner. The Energy Security Act incorporated a sound philosophy on the role of the SFC program managers in joint ventures that should be adopted by DOE in any demonstration program. Participation is "limited to financial participation only and shall not include any direct role in the construction or operation of the module."

6. Priority should be given to proposals that use existing facilities and sites when determining which proposals to select. It should be recognized that a stand-alone plant will usually be the most expensive type of technology demonstration and, therefore, should only be considered as a last resort.

7. The SFC should be encouraged to make provisions in its financial assistance packages for commercial synfuels plants to require the capability for testing advanced technologies at the plant site in the future.

CONCLUSION

In conclusion, the current federal energy research policy has created a "technology gap" for fossil fuels research by restricting the DOE role to proof of concept. Congress can take a bold step toward closing this "gap" by appropriating funds in FY 1986 for clean-coal technology demonstrations to be cofunded with industry. A joint DOE/industry program is needed now.

Mr. Chairman, this completes my testimony. I will be happy to respond to any questions.

Senator WARNER. On behalf of Chairman McClure and Chairman Domenici, I express the appreciation of this committee for your participation and your valuable contribution.

Mr. WEBB. Thank you, sir.

Senator WARNER. Unless there is further testimony that is desired to be given on behalf of someone, we will consider this hearing adjourned, and I thank you again.

[Whereupon, at 4:14 p.m., the hearing was adjourned.]

APPENDIXES

APPENDIX I

Responses to Additional Committee Questions

Department of Energy
Washington, DC 20585

November 15, 1985

Honorable Pete V. Domenici
Chairman, Subcommittee on Energy
Research and Development
Committee on Energy and Natural Resources
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

On May 16, 1985, Assistant Secretary William A. Vaughan appeared before the Energy and Natural Resources Subcommittee on Energy Research and Development to discuss the Department's Report to Congress entitled "Emerging Clean Coal Technologies".

Following that hearing, you submitted written questions for our response to supplement the record. Enclosed for your information are the answers to those questions, which also have been sent directly to the Committee staff.

If you have any questions, please have your staff call Ingrid Nelson or Cathy Hamilton on 252-4277. They will be happy to assist.

Sincerely,

Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

55-031 O - 85 - 5

POST-HEARING QUESTIONS AND ANSWERS

RELATED TO THE

MAY 16, 1985 HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

WITNESS: ASSISTANT SECRETARY VAUGHAN

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 1: Assuming Congress does appropriate money for clean coal technology -- what advice could you give us on the best way to select and evaluate technologies? What organizations or groups are in the best position to assist us?

Answer: If funds are appropriated by Congress for the Clean Coal Technology Program, DOE would issue a competitive solicitation. The solicitation would include criteria against which each proposal would be evaluated. A formal Source Evaluation Board (SEB) following strict guidelines would be established to issue the solicitation and evaluate the responses. It is anticipated that the SEB and its technical, cost and business management evaluation committee arms will include representation from DOE's Procurement, General Counsel, and Fossil Energy (Morgantown and Pittsburgh Energy Technology Centers as well as Headquarters) organizations as well as representatives from the Environmental Protection Agency.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 2: In your report you recommend that there be no Federal incentives for emerging clean coal technologies. You state as your reason:

> "... Projects selected to receive assistance under programs providing such incentives as direct funding, cost sharing, co-operative agreements, and price and loan guarantees, have with few if any exceptions been unsuccessful in commercializing new fossil technologies."

Could you give us some examples of such projects?

Answer: The Department of Energy (and its predecessor ERDA) has funded numerous demonstration projects during the period when federal energy policy included an emphasis on near-term technology demonstration and commercialization. Since that time, the national policy goal has evolved to achieving an adequate and balanced supply of energy at a reasonable price in the marketplace. This administration believes this balanced supply can best be achieved through systematic and cooperative efforts by government and industry. In response to this change, Fossil Energy's R&D was redirected to long range, high risk programs with high payoff potential. Thus, consistent with DOE's new role, Fossil Energy's demonstration programs were formally terminated in January 1981, and all activities associated with the demonstration plants have been concerned with contract closeout.

The dynamics of the marketplace have dictated these changes in developmental emphasis. The DOE demonstration program had its genesis in the days of the oil embargo of 1973. The embargo apparently triggered a national policy goal (no longer current) of energy independence. For a variety of reasons, including the economic impact and realities of achieving such a goal, that policy has been changed. Currently, per NEPP IV, an adequate supply of energy at a reasonable cost is the national policy goal.

Associated with "energy independence", the seemingly ever-increasing price of imported oil as a result of the actions by the OPEC cartel and the public concern about it set the stage for increased government activity to convert coal into petroleum substitutes.

Therefore, considerable effort was made by the President and the Congress to stimulate domestic production of oil, to conserve on energy consumption, and to develop alternative energy substitutes for oil, especially imported oil. In addition, the Federal Energy Administration initiated and completed its study on energy independence.

Consequently, one of the tasks assigned to the Energy Research and Development Administration (later incorporated into DOE) was to initiate programs to design, construct, and operate energy facilities of sufficient size to demonstrate the technical and prospective economic feasibility of utilizing various forms of non-nuclear energy. This was in addition to the historic more basic and applied non-nuclear energy R&D. Thus the Atomic Energy Commission's historical nuclear demonstration activities were given a counterpoint non-nuclear activity in ERDA.

It was in this context and time frame that the response to this perceived crisis was the initiation of the synthetic fuels pilot plant and demonstration plant projects. During this same period of time, the refiners acquisition cost of crude oil escalated from approximately $5 per barrel in 1973 to approximately $12 per barrel in 1978 to its peak of $39 per barrel in February 1981, increasing the perception that the economically viable synthetic fuels would be needed virtually as soon as possible.

While these projects served to reduce the "internal risk" (i.e., refine the process and reduce related specific technical uncertainties), such projects have little effect on "external risks" (i.e., uncertainties associated with the variable economics of the world energy marketplace that are strongly influenced by world oil prices, uncertainties associated with domestic policies of taxation, leasing, environment, related inflation, and the general uncertainties of basic and applied scientific and technical understandings and progress). In order for a technology to be commercially utilized, the technical risk must be manageable and also the process economics must be competitive with alternative fuels (i.e., oil). No one has been able to accurately predict the long term fluctuations in oil prices. As a result, multiyear projects initiated on the basis of favorable economic projections (rising oil prices) in the mid to late 1970s, found that by the time they were completed in the early 1980s, oil prices were actually dropping, making the given process non-competitive economically. Since February 1981, we have seen the oil price drop from its peak of $39 per barrel for refiner acquisition cost of crude oil to the current $28 level.

Therefore, operating under the national policy of advocating an adequate and balanced supply of energy at a reasonable price in the marketplace, the Administration wisely redirected the emphasis of DOE's fossil energy R&D to long-range, high-risk programs with high payoff potential. Accordingly, DOE's demonstration programs were formally terminated in January 1981, for the convenience of the government. Since that time, all activities associated with the demonstration plants have been concerned with contract closeout. The pilot plants continued to operate until planned operating programs were completed late in 1982. Attachment 1 provides individual fact sheets for the Major Pilot and Demonstration Plants concerned.

It should again be stressed that an energy technology must have technically manageable risks and must be economically competitive with alternative energy sources if it is to succeed in the marketplace. There is little point of building current technology demonstration projects when the fuel costs are two, three, or four times that of current and anticipated market prices. There is no compelling reason to subsidize construction of model current technology synfuel plants, such as those included on this list, when none of the projects has advanced to the stage of development where it could compete in the marketplace now or in the near future.

ATTACHMENT 1

DOE/Fossil Energy Sponsored Major Process Development Units,
Pilot Plant and Demonstration Projects
Not Commercialized as of May 1985

Project Title	Facility Type
Solvent Refined Coal (SRC-I)	Liquefaction Demonstration Plant
Solvent Refined Coal (SRC-II)	Liquefaction Demonstration Plant
Conoco High-Btu Pipeline Gas	Gasification Demonstration Plant
Illinois Coal Gasification Group High-Btu Pipeline Gas	Gasification Demonstration Plant
Memphis Light, Gas & Water Division Medium-Btu Industrial Fuel Gas	Gasification Demonstration Plant
W.R. Grace Gasoline Plant	Gasification Demonstration Plant

DOE/Fossil Energy Sponsored Major Process Development Units,
Pilot Plant and Demonstration Projects
Licensable for Commercialization as of May 1985

Project Title	Facility Type
Exxon Donor Solvent Process	Coal Liquefaction Process
Ebullated Bed (H-Coal) Process	Coal Liquefaction Process

DOE/Fossil Energy Sponsored Major Process Development Units,
Pilot Plant and Demonstration Projects
Operating Under Federal Government Loan Guarantee and
FERC Approved Price Arrangement as of May 1985

Project Title	Facility Type
Great Plains Coal Gasification Plant	Gasification Plant

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: Solvent Refined Coal (SRC)-I

Facility Type: Direct Liquefaction Demo Plant

Product Type: Solid clean burning fuel

TPC: $2,196M (less $677M anticipated revenue) DOE 92%; Others 8%

Plant Location: Newman, KY

Process Origin: Spencer Chemical (Gulf Oil)/EPRI/DOE

Time Period: 7/78 - 10/84

% Completed: 25%

Design Capacity: 6,000 T/D Coal

Project Participants: International Coal Refining Co., Commonwealth of KY, and DOE

Brief Narrative: DOE cost is $175.8 million. Prepared a complete engineering package, completed major process units, Piping and Instrument Diagrams, completed General Engineering Specifications, a total of 515 Mechanical Equipment Specifications, coal liquefaction reactions defined, thermophysical properties of coal-derived liquids data developed, and toxicological studies of coal-derived liquids and solids are still in process. The data are available to commercial enterprises. Burns and Roe Services Corp., after reviewing the preliminary draft of the final report, stated that the information from the SRC-I program is "a useful source document of lessons learned for further energy development projects." Under the terms of the DOE/ICRC contract, DOE would share royalties from the commercial licensing of SRC-I technology according to a set formula (85%/15% until DOE recouped its investment, then 50%/50% until the government had received 2.5 times its investment).

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: Solvent Refined Coal (SRC)-II

Facility Type: Direct Liquefaction Demo Plant

Product Type: Clean burning liquid fuel

TEC: $3,390M (less $1,830M anticipated revenue) DOE 50%, Japan 23%, FRG 23%, Gulf 4%

Plant Location: Ft. Martin (Morgantown) W. Va.

Process Origin: Spencer Chemical (Gulf Oil)/DOE

Time Period: 7/78 - 7/81

% Completed: 15%

Design Capacity: 6,000 T/D Coal

Project Participants: Gulf Oil, Japan, Federal Republic of Germany, and DOE

Brief Narrative: The final DOE cost was $73,719,770 and GOJ and FRG paying $28.4 million each. The Environmental Impact Statement was completed and distributed, the Health/Safety Plan completed, all permits and licenses applied for, Process Equipment Specifications completed, Process Design Specifications completed, Design Document List (except Unit 12, Hydrogen Treatment and Recovery System) complete, Process Flow Diagram (except Unit 13, Hydrodesulfurization System) complete, most Piping and Instrument Diagrams and Plot Plans and siting plan complete. The data are available to commercial enterprises.

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: CONOCO High-Btu Pipeline Gas

Facility Type: Surface Gasification Demonstration Plant

Product Type: High-Btu Pipeline Gas

TEC: $860M; DOE-$535, Industry-$325

Plant Location: Noble County, Ohio

Process Origin: Continental Oil Co.

Time Period: 3/77 - 10/83

% Completed: 15%

Design Capacity: 1270 T/D Coal

Project Participants: DOE-Phase I, DOE/CONOCO 50/50 Phase II and III

Brief Narrative: Phase I was 100% funded by DOE ($53,207,167). Successful run of Pittsburgh Seam #8 (in a PDU) coal, unsuccessful run of Ohio #09 - identified design changes, site selection and evaluation, Draft Environmental Impact Statement, identify all permits and licenses required, long lead time procurement items identified, and complete conceptual demonstration plant design. The data are available for commercial enterprises. DOE has royalty rights in the licensing to third parties of the technology demonstrated in the project.

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: Illinois Coal Gasification Group (ICGG) High-Btu Pipeline Gas

Facility Type: Surface Gasification Demonstration Plant

Product Type: High-Btu Pipeline Gas

TEC: $1,100M; DOE-$674M, Industry-$426M

Plant Location: Perry County, Illinois

Process Origin: ICGG

Time Period: 6/77 - 12/83

% Completed: 15%

Design Capacity: 2,210 T/D Coal

Project Participants: Mid-Continent Gasification Co.; Peoples Gas Light Coal Gasification Co., Inc.; CILCO Energy, Inc.; North Shore Coal Gasification Co., Inc; (ICGG) and DOE

Brief Narrative: Approximately 95% of Phase I was completed (Conceptual Development, Engineering, and Design) at a cost to DOE of $73,647,018. Conceptional design, site selection and evaluation, and final draft of Environmental Impact Statement were completed. Licenses and permits identified and those needed for design were obtained, 90% of design complete (drawing in the Records Holding Area), long lead procurement items identified, and master plan drafted. The data are available to commercial enterprises.

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: Memphis Light Gas & Water Division Medium Btu Industrial Fuel Gas

Facility Type: Surface Gasification Demonstration Plant

Product Type: Medium Btu Industrial Fuel Gas

TEC: $830M DOE-$729M/MLGW $101M

Plant Location: Memphis, Tennessee

Process Origin: MLGW

Time Period: 8/77 - 6/83

% Completed: 20%

Design Capacity: 3,110 T/D Coal

Project Participants: DOE and Memphis Light, Gas & Water Division

Brief Narrative: DOE total expenditure was $57,453,331. The project established that pretreatment of coal is unnecessary, eliminated ash disposal problem on cyclones by water jacket installation, and used University of London X-ray techniques to predict fluidized bed activity in the gasifier, the National Environmental Policy Act (NEPA) requirements were completed to include Plant Environmental Analysis, Environmental Impact Statement, and the Record of Decision. The data are available to commercial enterprises. This project later applied to SFC and was rejected.

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: W. R. Grace Gasoline Plant

Facility Type: Surface Gasification Demonstration Plant

Product Type: Gasoline blends, LPG, and butane

TEC: Capital Cost-$3 billion - Conceptual stage-$15 million

Plant Location: Baskett, KY

Process Origin: Texaco Coal Gasification and Mobil Methanol to Gasoline Processes

Time Period: 11/80 - 11/82

% Completed: 5%

Design Capacity: 25, Coal

Project Participants: DOE & W.R. Grace & Co., (Agricultural & Chemical Group)

Brief Narrative: (If plant was built, Grace would reimburse design costs.) Actual cost of work performed was $12 million. Basic design parameters developed, plant process and mechanical design, cost estimates, and site evaluation completed. Permits and licenses and materials identified, and the environmental analysis completed and the draft Environmental Impact Statement completed. Completed data are available for commercial enterprises.

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: Exxon Donor Solvent (EDS)

Facility Type: Direct Liquefaction Pilot Plant

Product Type: Liquid Fuel

TEC: $343.25M DOE 47.3%
Others 52.7%

Plant Location: Baytown, Texas

Process Origin: Exxon

Time Period: 1/76 - 12/85*

% Completed: 100%

Design Capacity: 250 T/D Coal

Project Participants: Exxon, EPRI, Japan CLD, Phillips, Anaconda, Ruhrkohl AG, ENI (Italy) and DOE

Brief Narrative: Established data base for scale-up; constructed and operated plant in safe, environmentally acceptable manner; established process for commercial licensing; established licensing program; and verified hybrid boiler as promising bottoms process technology.

* Pilot Plant operations were completed in September 1982; contract for Plant Dismantlement, November 1982; Bottoms Gasification Tests at TVA complete in September 1983; Hybrid Boiler Development in October 1983; plant dismantled and disposition made, December 1983; Bottoms Gasification Tests at Oberhausen-Holten, FRG, January 1984; and will complete the Toxicology Program in December 1985. Any royalties derived from marketing of the technology developed in the pilot plant will be shared by DOE, on an unlimited payback basis, in the same manner that costs were shared.

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: H-Coal, Ebullated Bed

Facility Type: Direct Liquefaction Pilot Plant

Product Type: Liquid Fuel

TEC: $320.3M DOE - 86.8%; Others - 13.2%

Plant Location: Ashland, KY

Process Origin: HRI/Ashland Oil

Time Period: 12/74 - 12/83

% Completed: 100%

Design Capacity: 200 T/D Coal

Project Participants: Ashland Synthetic Fuels, Inc.; Mobil; Conoco; EPRI; Std. of Indiana; VEBA Oel; and DOE

Brief Narrative: Verified design yield, demonstrated adequacy of materials, demonstrated operability of key components (letdown valves, block valves, slurry pumps, ebullating pumps) and provided data base for scale up. The Tennessee Eastman Chemical Project has used technical data from the H-Coal Project for adapting "let-down valves" to their project. They give credit to H-Coal Technology for the successful design of this phase of their operation. Any revenues derived from patents resulting from the technology developed by this project will be shared by DOE and the industrial participants according to their percentage sharing of total project costs.

On January 26, 1983, the title to the H-Coal Pilot Plant was transferred to Ashland Synthetic Fuels, Inc. (ASFI). The plant was placed in a "mothballed" status with DOE having the right to use the H-Coal for an ~~independent Government-funded~~ H-Coal Pilot Plant ~~Program~~ for a period of up to three years after the transfer date (December 31, 1985).

DOE/Fossil Energy Sponsored Major PDU,
Pilot Plant, and Demo Projects

Project Title: Great Plains Coal Gasification Plant

Facility Type: Coal Gasification

Product Type: High-Btu Pipeline Quality Gas

TEC: $2,276.9 million,
DOE Loan - $1,536.9 million
GPGA - $740 million

Plant Location: Beulah, N.D.

Process Origin: Lurgi Pressurized, Fixed Bed Gasification Process w/Lurgi Methanation

Time Period: Aug. 6, 1981 - Present

% Complete: 100%

Design Capacity: 137.5 MMSCF/D

Project Participants: ANG plant managers, Great Plains Gasification Associates (GPGA) a consortium of American Natural Resources Company; MidCon Corp.; Pacific Lighting Company; Tenneco, Inc.; and Transco Energy Company (original owners).

Brief Narrative: The Great Plains Coal Gasification Plant is the U.S.'s first commercial high-btu gasification synthetic fuels project based on coal conversion.

The Department of Energy approved a loan guarantee of up to $2.02 billion on January 29, 1982. Funds are provided by the Federal Financing Bank. In accordance with the provisions of P.L. 97-100, management responsibility for the Great Plains Coal Gasification Loan Guarantee remains with the Department of Energy.

The plant is designed to produce 137.5 million cubic feet/day of high-Btu pipeline quality synthetic gas (equivalent to 45 BCF annually or 20,000 bpd). To do this the plant consumes 4.7 million tons of coal/year.

Initial delivery of gas to the pipeline occurred on July 28, 1984. Gas has been delivered to the pipeline each day since October 16, 1984. During the months of September and October 1985, production has averaged over 90 percent of design capacity.

On August 1, 1985, GPGA submitted a termination notice as an event of default by the partners on the Loan Guarantee Agreement. Since that date, DOE has continued to operate the plant with ANG still serving as the plant managers pending decision on final disposition of the plant.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 3: Is the willingness of the private sector to invest in commercialization a good indicator of a technology's potential? Is the willingness to cost-share with the Federal government an equivalent indicator? If not, why not?

Answer: The willingness of the private sector to accept the full risks of investment in research and development and commercialization activities is an excellent indicator of a technology's potential. The willingness of the private sector to cost-share projects is not an equivalent indication although it provides some indication of the private sector's assessment of the technology's potential.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 4: When you select a research project for federal support in the area of coal cleaning, for example, aren't you affecting the free-market mechanism at that point?

Answer: Research projects normally committed to by Fossil Energy are those projects that are consistent with the high-risk long-term payoff criteria for federal funding. Initially, they are not economically attractive nor are they, in many instances, technically or environmentally desirable in the marketplace. The work is generic enough that it often has multiple applications. The goals and objectives of our research activities are tailored to identify an appropriate exit from R&D support whereby free market forces can select and commercialize the most efficient and effective technologies without federal subsidies.

If the effort is focused on basic research and development it is likely to have a positive effect on the free market by providing basic knowledge that often can be used in alternative applications that only the market is best able to determine. If focused on applied technology demonstration, such efforts will often be wasted since the government is in a poor position to select technologies that will utlimately prove to be commercially feasible. Such waste, by raising the tax burden on individuals and businesses, weakens the productive capability of our economic system.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 5: If you were funded and directed to give awards for clean coal technologies, could you use the 176 submissions you have received for your report? If not, why not?

How much of your present budget falls under the category of clean coal technology?

Answer: No, the 176 submissions could not be utilized. In section 321 of the Fiscal Year 1985 Continuing Appropriations Act, P.L. 98-473, DOE was directed to solicit from the private sector "statements of interest in, and proposals for projects employing emerging clean coal technologies," to analyze the submissions and to submit a report to Congress on our findings. In the Commerce Business Daily and Federal Register Notices issued late in calendar year 1984 announcing this initiative, DOE clearly stated that the information submitted in response to our announcements was to be used as the basis for an informational report to Congress and not as the basis for the awarding of contracts. It was also pointed out that no funds were appropriated for this program. Many of the responses were thus constructed informally. The submissions were not ranked, nor were they competitively evaluated. Rather, they were analyzed to draw out the pertinent information to include in the report which was submitted to Congress on May 1, 1985.

A Clean Coal Technology solicitation calling for the submission of proposals that may be funded from FY 1986 appropriations (if so provided) is not related from a procurement perspective to the Section 321 activity. It is a brand new activity that will call for formal proposals which will undergo evaluation against well-defined qualification and evaluation criteria and program policy factors stated in the solicitation. The proposals so received and evaluated will be ranked and selection for cost-shared funding will be made therefrom.

Since environmental acceptability is an important objective of every one of our coal technology development programs, in a very real sense Fossil Energy's entire coal research program or approximately $149.2 million requested for FY 1986 falls into the category of "clean coal technology." Indeed, all but one of the major categories in the coal R&D program were represented by at least one informational proposal submitted under the Section 321 activity.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 6: In your statement you say you will be doing further analyses on the clean coal technologies. When will that be completed? Could you be more specific about the additional analyses to be done? What does it entail?

Answer: The Department committed itself to submit a supplemental report to Congress which would further characterize the emerging clean coal technologies against a set of criteria. That "Supplemental Report to Congress on Emerging Clean Coal Technologies" was completed by a group of contractors for DOE and submitted to Congress in September 1985.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 7: You had a considerable number of submissions for Atmospheric Fluidized Bed (AFB) demonstrations. We are about to complete the construction of a major utility demonstration done on a cost-sharing basis with EPRI and TVA. We also have over 50 industrial boilers in operation in this country. Is it realistic to believe the private sector would want to do more demonstrations? Are there valid reasons for multiple demonstrations?

Answer: Besides the DOE, EPRI and TVA cost shared AFB utility demonstration, EPRI is participating in two additional AFB utility demonstrations. One is with Colorado Ute, a 100 MW circulating unit, and the other is a 100 Mw retrofit bubbling bed with Northern States Power. These demonstrations represent three distinct applications of the AFB technology. One unit (TVA) will be using high sulfur eastern coal; the other two will use western coals.

The demonstrations should give the private sector ample information for commercialization of AFB in the utility sector. In addition, large industrial and high capacity light industrial AFB's are now considered commercial. In this instance there is no need for further demonstrations.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 8: A number of submissions for demonstrations rely on further R&D prior to their construction (like MHD and Pressurized Fluidized Bed). Were the submissions suggesting that new Federal R&D be done or existing R&D be accelerated?

Answer: A number of the submissions received in response to DOE's Program Announcement for information regarding emerging clean coal technologies were for the conduct of research. Some of the proposals were directed at new phases of research which DOE is not conducting as a part of its R&D program. Others called for expansion of current DOE R&D programs.

Of the true demonstration projects proposed, some called for the completion of DOE's ongoing research as a prerequisite to the initiation of the demonstration projects.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 9: A number of the utility submissions state as a justification for direct Federal support the fact that such costs are not allowed by Public Utility Commissions. Why doesn't the utility investor have an incentive to do this R&D?

Answer: Utility companies represent a heavily regulated industry. Historically, the Public Utility Commissions have been relatively stringent in approving research and development investments for inclusion in the utility rate base even though such investments may reduce costs or improve service in the long term. This creates, in many instances, a disincentive for R&D investments. In the current regulatory environment, it would be difficult for a utility to justify and provide funding for risky, long term projects to demonstrate a technology.

If the utility shareholders wished to invest in R&D, they would only do so if they could reap the economic benefits. Historically, however, most public utility companies have taken the position that the investors must pass on economic savings to the customers when the research succeeds, while absorbing the losses themselves if the research fails.

Furthermore, the current air pollution standards do not create economic incentives for new technology that would be considered by public utility companies or utility shareholders as they decide on the risks and benefits of R&D. R&D for both efficiency and air quality is seen by both groups as optional.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 10: We have spent a great deal of money on phosphoric acid fuel cell demonstrations. Why does the private sector want to do seven more?

Answer: The seven phosphoric acid fuel cell systems proposed for DOE supported demonstration are outlined in the Report to Congress on Emerging Clean Coal Technologies, May 1985. The private sector apparently believes that such demonstrations of coal-fueled phosphoric acid fuel cell systems (coal gasifier, gas cleanup and fuel cell power generation) will further advance the commercial application of these systems for electric utilities. Previous demonstrations of phosphoric acid fuel cell systems (4.8 MW and 40 kW units) were natural gas fueled systems for electric utility and on-site applications.

All subsystems that would be involved in a coal-fueled phosphoric acid fuel cell powerplant (gasifier, gas cleanup subsystem, fuel cell stacks and balanced of plant power generating equipment) have been proven singularly or in combination in various pilot plants and demonstrations. Further, Federal support of such demonstrations is unwarranted.

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 11: Have any of the technologies submitted been demonstrated in other countries?

Answer: Atmospheric Fluidized Bed (AFB) Combustion technology has proceeded with commercial large scale industrial, industrial cogeneration, and utility applications in other countries.

Pressurized Fluidized Bed (PFB) technology is not as advanced in application as AFB. A single project to date involves a district heating plant in Stockholm, Sweden, and calls for the retrofit of a cogeneration plant which would produce 235 MW heat and generate 133 MW electricity using 2 coal fired modules supplied by ASEA-PFB, Sweden (formally Stal-LAVAL). The project is in the planning stage, with commissioning scheduled in 1989. Additionally, Deutsche Babcock is investigating a 335 MW PFB combined cycle power plant for proposed demonstation in Germany in the early 1990's.

Coal gasification technologies of the types submitted in response to the Emerging Clean Coal Technologies informational solicitation have been demonstrated in other countries and include:

GASIFICATION TECHNOLOGY	LOCATION
o Shell Entrained Flow	Hamburg, West Germany, at 150 ton/day pilot plant
o KGN Fixed Bed	Huckelhoven, West Germany, at 36 ton/day pilot plant
o KRW Ash Agglomerating Fluid Bed	Proposed demonstration of KRW gasification process in Shanxi Province, Peoples Republic of China, at 265 ton/day pilot plant
o U-Gas Ash Agglomerating Fluid Bed	Proposed demonstration of U-Gas gasification process at Mazingarbe, France, at 220 ton/day pilot plant

GASIFICATION TECHNOLOGY	LOCATION
o British Gas Corporation/ Lurgi Slagger	Westfield, Scotland, demonstration of scaled-up (8 foot ID) gasifier at 700 ton/day pilot plant
o Wellman-Galusha	South Africa, various locations and sizes
o K-R Process for Iron Making	Pilot plant demonstration in West Germany at 60,000 ton/year

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

Question 12: In the area of MHD, the projects proposed sound very much like what DOE was proposing to do in FY 1985. Where do you stand on that? Why hasn't a program been put together?

Answer: Early in 1984, DOE, in consultation with the private sector, realigned the MHD program. The previous program, which focused on subsystems development was redirected to a multiyear, cost-shared program targeted toward proof-of-concept (POC) testing. The total cost of the POC program, including private sector cost sharing, was estimated to be approximately $150 million. The POC program was to have been completed in 1989. This program was detailed in the Department's Report to Congress on the MHD Program, dated June 7, 1984. By the end of Calendar Year 1984, there was no indication from the private sector that significant cost sharing would be forthcoming. The Department, therefore, reassessed its priorities for fossil energy technologies and determined that other fossil energy technologies would contribute more directly to DOE and national needs with lower investment requirements, and with significantly more cost sharing from the private sector. Therefore, the Department proposed to terminate the MHD program in FY 1985, defer $15 million of program funds, and make the major MHD facilities and equipment available to private developers. The Department's deferral request was disapproved in June 1985.

No funds were requested for the MHD program for FY 1986. The Department continues to fund the POC program pending Congressional action on FY 1986 funding.

QUESTIONS SUBMITTED BY SENATOR PETE DOMENICI

Question 1: Have you analyzed which of these technologies will result in lower emissions, if put in place, than existing technologies? Have you analyzed which would be more economical? Will you do this as part of the further work you plan?

Answer: In DOE's "Supplemental Report to Congress on Emerging Clean Coal Technologies," assessments of each technology against environmental, economic, technical maturity and applicability criteria were reported. No attempt was made to rank the technologies from best to worst because factors such as uncertainties in estimating technology performance and economics, site specific factors, and others make such an exercise meaningless. Rather, a suite of technologies each having its own attributes are being developed from which the private sector can choose to meet their needs. It should be noted, however, that there are currently no incentives or requirements for partial reduction of emissions, short of the new source performance standards for NEW power plants.

QUESTIONS SUBMITTED BY SENATOR PETE DOMENICI

Question 2: One of your submissions requested an innovative technology waiver of SO_2 NSPS as its only "assistance." Have they been successful in getting it? Why hasn't EPA provided it especially in view of the fact that they want to demonstrate a technology the EPA has been promoting? Could this kind of "assistance" be of value to other projects? Why is it necessary?

Answer: The subject waiver was not provided by EPA despite the recommendation of DOE to EPA that such a waiver be granted and the endorsement of EPA's Air and Engineering Research Laboratory, which has been responsible for developing and promoting LIMB Technology. It is our understanding that EPA offered the proposer a 10-year waiver from the requirements. However, the proposer sought a lifetime waiver which was unacceptable to EPA. This type of a waiver could be of value to similar projects. Uncertainties exist with respect to the operability and performance of new technologies when scaled to demonstration or commercial sizes. Problems are most often encountered in the shakedown and early operation of these projects. An innovative technology waiver would allow these types of projects to operate in non-compliance with NSPS for a specified period of time while the required troubleshooting and modifications are taking place.

QUESTIONS SUBMITTED BY SENATOR PETE DOMENICI

Question 3: Some of the submissions propose to use natural gas to reduce NO_x through "reburn." It has been suggested that such an application would help keep NO_x down if a coal-water mixture were used in an old oil-fired plant. Would the use of natural gas in such a boiler be a violation of the Fuel Use Act?

Answer: No. The Fuel Use Act (FUA) does not prohibit the use of natural gas in combination with coal-based fuels for NO_x control in existing facilities. If an existing facility is currently subject to a prohibition order (FUA or the Energy Supply and Environmental Coordination Act of 1974), the operator would have to obtain a modification to the order to use a mixture of natural gas to meet environmental requirements.

An operator, desiring to convert from oil to coal-based fuel with natural gas, may seek a FUA prohibition order (for a mixture) from EPA since a powerplant may be subject to the current stringent NSPS (i.e., a major modification under the Clean Air Act) but would not be if it had a FUA prohibition order.

QUESTIONS SUBMITTED BY SENATOR PETE DOMENICI

Question 4: Would the repeal of the Fuel Use Act increase the pace for us to achieve our air quality goals?

I understand from the report "Evaluation of the Environmental and other Benefits of the Selected Use of Natural Gas" by the Environment Research and Technology, Inc., that select gas use not only reduce SO_2 emissions, but also reduce NO_x emissions and waste ash. If indeed we can reduce emissions more efficiently, would we improve our air quality more expeditiously?

Answer: Repeal of the Fuel Use Act would remove a major complexity in determining which fuel form makes the most economic and environmental sense. Today, operators can obtain exemptions (e.g., cost, mixtures, or environmental exemptions) from Fuel Use Act prohibitions applicable to new facilities. The Fuel Use Act is not generally applied to existing facilities, unless the operator voluntarily initiates action to obtain a prohibition order. Nevertheless, the natural gas industry maintains that the Fuel Use Act has a "chilling effect" on the increased use of natural gas. In FY 1985, ERA received requests for exemptions from prohibitions for 75 units with a total capacity of 4330 megawatts. Most exemptions have been granted, some are still in process and none have been turned down. Natural gas combustion generally emits less pollution than coal combustion, even if the coal combustion is well controlled. Whether it is more economical to substitute fuels or to apply pollution control hardware is a separate question, and almost certainly hinges on the specific application. In either case, having a greater choice of fuels could only make it easier for the marketplace to respond to our air quality goals.

QUESTIONS SUBMITTED BY SENATOR JAMES McCLURE

Question 1: Aside from the need to retrofit current coal plants to meet ever tightening environmental regulations, we also need to address the need for new plant additions as electricity demand grows. Current electrical growth projections indicate we'll need to provide anywhere from 4 to 60 million kilowatts of additional capacity by the year 1995. Given the long leadtimes of nuclear plants, nuclear power will not contribute to these near-term additional requirements even if utilities started ordering new nuclear plants today. Thus, coal will be the only practical source of new generating capacity over the next ten years.

Now, even coal plants typically take 7 or 8 years for construction. Thus, any clean coal technologies we might need for plants coming on line by 1995 will have to be developed within the next 2 to 3 years. This is a very constrained time frame and obviously will require a rigorous, aggressive effort in order to meet the 1995 "deadline". In all practicality, do you think the private sector could meet this schedule without appropriate incentives and support from the Federal Government?

Answer: This question encompasses several issues. The first is the implicit statement that only advanced coal technologies can provide the necessary power. Conventional pulverized coal technology, equipped with conventional technology (scrubbers for SO_2 and low-nitrogen oxide boiler/burner design) can meet all federal performance standards. Advanced technologies will certainly emit less, but it is not clear that the lower level of emissions will be necessary for the areas which need additional capacity.

Additionally, recent years have seen a increasing flow of energy from other sources, both renewables and cogeneration (California has many offers of cogenerated power than it will be able to use until at least the mid-1990s). Much of the cogeneration is fueled by natural gas.

The second issue relates to the construction time assumed in your question. Conventional coal technologies do require 7 to 8 years to construct, but some advanced technologies require much less. For example, the 100 MW Cool Water

integrated gasification and combined cycle powerplant built in California, which demonstrates a modular approach to power generation, required 28 months from groundbreaking to startup. Additionally, some "clean coal technologies" are actually the cleanup systems that clean the gases from a fairly conventional boiler. It is feasible that a utility could modify its plans to substitute an advanced cleanup technology, even after construction of the boiler itself had commenced. Such a decision would be disruptive, due to permitting and long-term ordering of components, but it is feasible and could occur if the cost differential of the advanced technology were sufficiently favorable.

The point of all this is that we may have more time than the question assumes. We also need to avoid confusing trends or milestones with "deadlines" or endpoints. Our planning needs to address a shifting web of trends, not a single outcome that one treats as an independent event.

It is difficult to estimate how much lead time is needed for widespread acceptance of fundamentally new technologies. Given that the first few applications of a new concept allow for subsequent refinements, a cautious behavior is not necessarily bad. The rapid promotion of a new technology by the government is not desirable. A broad-based basic research program to provide industry with a slate of options is the most effective approach.

Between the basic power generating options available to utilities -- not all of which are coal based -- and the variety of coal emissions cleanup techniques that have been proven in DOE labs and in prototypes, there is every reason to believe that industry will be able to meet the need for future generating capacity.

QUESTIONS SUBMITTED BY SENATOR JAMES McCLURE

Question 2: So much emphasis is placed on air pollution -- primarily SO_x and NO_x -- that I'm afraid we might be ignoring the potential problems of liquid and solid pollutants in the "Clean Coal" scheme of things. In fact, some of the emerging technologies, while significantly reducing air emissions, will actually result in substantial increases in liquid and/or solid wastes.

How will these emerging technologies affect a utility's ability to conform to regulations arising from the Clean Water Act or the Resource Conservation and Recovery Act? Don't we need to look at the entire picture, so that we don't end up trading one type of pollutant for another? Which of the emerging clean-coal technologies holds the greatest promise of reducing all categories of emissions in a cost-effective manner?

Answer: The environmental performance analysis for the emerging clean coal technologies concluded that overall environmental performance of AFBC, PFBC, Fuel Cells, underground and surface coal gasification, and direct and indirect liquefaction scored between "good" and "very good" (small to negligible amounts of easy to handle material). However, no technology rated "very good", and this indicates that effective pollutant control strategies that allow coal to be used in an environmentally acceptable manner will require a combination of two or more technologies.

Most technologies scored "medium" (large amounts of easy to handle material) on secondary liquid and solid pollutant emissions, implying these emissions were similar in quantity and kind to those of a conventional coal boiler with no scrubber, i.e., large amounts of dry, nontoxic and non-hazardous wastes such as bottom ash. Surface and underground coal gasification and systems which use them rated "poor" because they are less efficient than direct combustion and large quantities of solid and liquid wastes are produced which may require special handling. Utilities and industry, as the end user of these technologies are very concerned over emissions and each is analyzing these technologies for their specific applications.

Finally the analysis made a comparison between the literature/research review and the performance projected by the panel of coal technology experts. In general the review ratings and the expert opinions were in agreement.

SUMMARY OF EXPERT OPINIONS ON OVERALL ENVIRONMENTAL PERFORMANCE

Technologies	Expert 1	2	3	4	5	Average Rating	Range
Flue Gas Cleanup							
- Post-Combustion Gas Cleanup	3	3	4	4	4	3.6	3-4
- Dry Sorbent Injection (LIMB)	2	2	4	3	4	3.0	2-4
Fluidized Bed Combustion							
- Atmospheric	4	3	3	4	4	3.6	2-4
- Pressurized	4	3	3	5	4	3.8	3-5
Surface Coal Gasification	5	5	4	5	5	4.8	4-5
Advanced Coal Cleaning							
- Advanced Physical Coal Cleaning[1]	2	2	2	3	3	2.4	2-3
- Chemical Coal Cleaning[1]	4	2	2	3	3	3.2	2-4
Coal-Fueled Diesel Engines	2	3	2	1	1	1.8	1-3
Coal-Fueled Gas Turbines	2	3	2	2	1	2.0	1-3
Advanced Combustors	2	2	3	3	4	2.8	2-4
Alternative Fuels	2	3	2	3	3	2.6	2-3
Fuel Cells	5	5	2	3	1	3.2	1-5
Coal Liquefaction[2]	3	4	3	2	1	2.6	1-4
Underground Coal Gasification	5	3	4	3	1	3.2	1-5
Hot Gas Cleanup	4	5	2	1	1	2.6	1-5
Magnetohydrodynamics (MHD)	2	1	2	1	1	1.4	1-2

Key:
5 - Very High Potential
4 - High Potential
3 - Medium Potential
2 - Low Potential
1 - Very Low Potential

[1]Four of the experts gave one combined rating for advanced physical coal cleaning and chemical coal cleaning

[2]The experts did not rate indirect coal liquefaction separately, but included it under surface coal gasification.

NOTE: This data was extracted from the DOE Supplemental Report to Congress on Emerging Clean Coal Technologies, dated August 1985.

QUESTIONS SUBMITTED BY SENATOR JAMES McCLURE

Question 3. In addition to identifying various demonstration projects of promise in the areas of clean coal technology, the ERAB report also stresses the need for greater basic research on coal, to better understand its structure, composition, and combustion characteristics. Obviously, such fundamental research could provide much needed benefits to all coal technologies.

In view of the need to accelerate the introduction of new clean coal technologies, shouldn't we also be accelerating the fundamental research on coal that is so vital to the ultimate success of all emerging clean coal technologies? Shouldn't DOE be expanding its lab research efforts -- perhaps in conjunction with universities -- to broaden our understanding of coal and coal combustion phenomena at a sufficient pace to meet the demands of the emerging technologies?

Answer: Fundamental research is helpful to technology development. The Department believes that the existing Fossil Energy AR&TD program is an excellent example of a balanced program in fundamental coal research. The funding for this program is included in three major activities: AR&TD; Surface Coal Gasification - Advanced Research; and Coal Liquefaction - Advanced Research. Funding for this program has been approximately $40 million per year. It provides basic research support for all of the Fossil Energy coal programs.

In FY 1985, approximately 26 percent of this funding was allocated to universities and 33 percent to national laboratories. The remainder was spent at Fossil Energy's own in-house laboratories, PETC and METC, and industrial and not-for-profit research organizations. In FY 1986, we are expanding the research performed by universities by increasing funding for the University Coal Research Program approximately 33 percent over the FY 1985 appropriation. The additional projects will include research to broaden our understanding of coal and coal combustion phenomena and should help the development of clean coal technologies. Some specific research topics planned for the FY 1986 University Coal Research Program include: the

structure and reactivity of coal; fundamental research directed toward an understanding of organic and inorganic chemistry of coal with respect to conversion and utilization; chemistry of formation and/or elimination of gaseous and liquid pollutants arising from coal conversion and utilization reactions.

In view of the program described above, the Department believes that it has a basic research program that broadens our understanding of coal and coal combustion phenomena at a pace sufficient to meet the demands of the emerging clean coal technologies.

Electric Power Research Institute
Follow-up Questions from
Hearing on Clean Coal
Technologies--

ATTACHMENT 1

Questions Posed by Senator Ford

1. What is the effect on developing clean coal technologies of requiring scrubbers on all new coal power plants?

   In my opinion, if scrubbers were mandated on all new coal power plants, the introduction of advanced clean coal technologies such as integrated coal gasification combined cycles (IGCC) and atmospheric fluidized bed combustion (AFBC) would be delayed in commercial introduction by 10-15 years. Such a law would force electric utilities to use antiquated technologies for new power plants to be built in the mid- to late-1990s just at a time when the new clean coal technologies would be ready to enter the marketplace. Since the electric utility industry is extremely conservative in making financial/risk decisions, they most likely would delay any plans for adopting a fundamental new technology for coal use until well into the 21st century.

2. What would be the effect on developing clean coal technologies of requiring scrubbers on existing coal power plants?

   We have not specifically assesssed this situation; however, such a requirement would necessitate adding scrubbers to over 200,000 MWe of existing coal-fired plants of varying age, but most of which would be 20-25 years old. In many cases, the coal plant site would not permit scrubbers to be added without major plant revisions and, in some cases, plant acreage increases. The estimated cost to the electric utility industry would be $15-25 billion per year (1985$) over the remaining life of the affected units and would probably require the additional cost of purchased power (if available from a neighboring utility) of another $2-3 billion per year. Many utilities who are in tight financial condition due to nuclear units just coming on line would probably be bankrupt by such an action. The obvious implication to new technology is that it would delay the introduction indefinitely since all the available utility capital would be drained with the addition of scrubbers. It should also be understood

that the addition of scrubbers will reduce the net output of each plant by 6-10%; therefore, additional capacity of 12,000 to 20,000 MWe would have to be added just to retain the same system capacity. Obviously, even with low load growth of 2% per year, additional capacity would need to be added in parallel, even further increasing the financial burden on the utilities. I believe such legislation would be devastating to our Appalachian, Southern and Midwestern utililties who rely so heavily on coal for power generation.

3. If the Congress enacted legislation requiring a 12 million ton reduction in SO_2 emissions by the early 1990s, what would be the effect on developing clean coal technologies?

We have carefully evaluated this situation. Even if we assume that coal washing and fuel switching (to western low sulphur sub-bituminous coal) were successful, at least 70,000 MWe of existing coal-fired power plants would have to be retrofit with scrubbers. The estimated cost to the electric utility industry and its customers would be $5 to 10 billion per year (1985$) plus replacement power costs of at least an additional one billion dollars per year. Further this requirement is unlikely to be met by the early 1990s as those utilities most impacted could not likely raise adequate capital to modify all units simultaneously. The "average" cost of retrofitting each coal fired unit has been estimated to be $250/kWe (1985$); thus a utility such as American Electric Power Company with over 16,000 MWe of noncompliance coal fired capacity would have to raise 3-4 billion dollars to be in compliance. This just does not seem to be a meaningful approach.

From a new technology standpoint, it would appear much more prudent to begin retiring old, polluting coal power plants and begin substituting clean coal technology such as IGCC or AFBC units which would provide a long term air emissions control solution. Studies which we have performed at EPRI indicate that substitution of advanced clean coal technologies could achieve the same level of emissions reduction by 2005-2010 and <u>maintain</u> low air emissions in the future. We see no catastrophic ecological consequences which would necessitate achieving SO_2 reductions by the mid-1990s; therefore, we believe that a policy which fosters advanced coal technology will provide the most cost effective, meaningful air emission control strategy.

ATTACHMENT 2

Questions from Senator Pete V. Domenici

1. Much of the pressure for further mandatory reductions in SO_2 and NO_x comes from the fact that a few utilities are not in compliance with existing standards. If it weren't for these utilities, would we have the pressure and need for a clean coal technology program?

First, let me say that there are a great number of utilities throughout Appalachia, the Southeast, and Midwestern states which are exceeding today's SO_2 emission standards. I have not surveyed all the utilities which have at least one plant out of compliance, but in a recent study which we conducted, there are over 20 utilities, with a combined capacity of nearly 150,000 MWe of coal, in the MAIN and ECAR regions alone and over 200,000 MWe nationally which exceed today's standards by varying degrees. Therefore, any legislation imposing SO_2 reductions impacts a large segment of the electric utility industry.

In response to your specific question, it is clear that there is a need for a clean coal technology program. Even with very low load growth projections of 2% per annum, the utility industry will need to add approximately 200,000 MWe of additional capacity by the year 2000. With the problems of licensing nuclear power plants and limitations on the use of oil and gas for new power generation, the electric utility industry will clearly turn to coal for new plant additions. If the industry is to have the flexibility to purchase local coals, e.g., Appalacnian, Southeastern, or Midwestern bituminous coals, we must develop advanced coal technologies such as integrated coal gasification combined cycles (IGCC) and atmospheric fluidized bed combustion (AFBC) to adequately control air emissions. Therefore, I believe a government/industry co-operative program to develop and demonstrate clean coal technology is clearly in the national interest. As an addendum to this response, I am enclosing a copy of a paper which I presented on the subject earlier this year, and the rationale for a federal role. I respectfully request that this information be added to my written response and included in the printed hearing record.

2. How do we know that utilities will adopt new technologies unless they are mandated? Even when we mandated certain clean air standards, some did not comply.

   Of course, I cannot assure you that the utility industry will adopt new technologies even if full scale demonstration projects are successful. However, I can assure you that unless full-scale demonstration projects are conducted, it is very unlikely that new technologies will be adopted. Based on the very positive reaction which we have received from the electric utility industry regarding our early success at the Cool Water IGCC plant, I believe the industry is looking for new, better ways to utilize coal. Further, there is a growing desire among chief executives in the utility industry to bring electricity and the environment into consonance. Not all utilities share this ethic, but it's growing and bodes well for the adoption of new clean coal technologies if they are successfully demonstrated.

3. You compared the emissions from a few technologies to conventional coal boilers with scrubbers in your testimony. Could you provide us with similar comparisons for the other technologies in DOE's report? Do you think all of the submissions represent better clean air technologies than our present technologies?

   I will respond to both questions simultaneously and will attempt to provide you estimates of the maximum SO_2 removal potential for most of the key technologies which were proposed to the DOE. This may not be a comprehensive list, but covers the major options. The control approach is presented in the context of the time frame in which the technology could be implemented, i.e., short-term (5-10 years), intermediate-term (10+ years), and long-term (post 2000).

Control Approach	Estimated Maximum SO_2 Removal Potential (Percent)
Near-Term	
Physical Coal Cleaning and Assay	20
Chemical Coal Cleaning	70
Advanced Flue Gas Desulphurization	90-95
Advanced Combustion Control	40-60 (NO_x not SO_2)
Intermediate-Term	
Integrated Coal Gasification Combined Cycle Power Plants	99+
Atmospheric Fluidized Bed Combustion	95
Long-Term	
Coal Gasification/Advanced Systems Including Fuel Cells and Methanol Synthesis	100
Pressurized Fluidized Bed Combustion	90
Open Cycle MHD	90

4. Are you concerned, as DOE is, that DOE support for clean coal technology will subvert free market signals?

I do believe that DOE has a basis for their concern; however, I believe the best interests of the nation, the electric utility industry, and their customers warrant a clean coal program. My basic argument is included in the paper which I have enclosed with my response. It was the federal government who imposed the requirements for air emissions control to protect the public well-being. In my opinion, it is incumbent upon the government to assist the utility industry in developing economically competitive, environmentally acceptable clean coal technologies to meet this public need. Although certain suppliers have developed emission control systems and have made them available to the electric utility industry, very few of the present solutions are acceptable to our industry. We need to develop advanced systems for coal utilization on a broad competitive basis to ensure both quality of product and ability to produce power at the lowest cost for the consumer, and simultaneously meet stringent air emission control requirements.

5. DOE has said that their previous assistance programs for projects have failed. Do you share that opinion? How could we make a clean coal program better?

I have been associated with a number of clean coal and coal conversion projects cofunded by ERDA/DOE and industry over the last ten years. The results of these joint programs are mixed.

In the case of the H-Coal, Exxon Donor Solvent, and Wilsonville pilot plant projects, all three projects achieved their technical objectives; however, they did not produce competitively priced liquids from coals because world oil prices fell rather than continuing to escalate. However, in my judgment, these projects were technical successes. Also I would like to call to your attention the fact that in each project there was substantial private sector funding, so there was a strong individual commitment to succeed.

In parallel, the federal government supported the Rivesville AFBC plant, the SRC I and SRC II demonstration projects, and initiated many large scale projects such as the City of Memphis U-Gas project. In all of these cases, the federal government bore the primary financial burden and the projects were either not constructed or, as in the case of Rivesville, operated poorly. The fundamental problem with each of these projects is that there was no well developed technology base to provide confidence in scaling to these large scale systems. The decision to proceed with these projects were politically motivated, and the processes/plants were not technologically ready for full-scale demonstration. We, at EPRI, stated this in a private report which we provided to ERDA before many of these projects were initiated, but the reports were ignored.

Just for comparison purposes, before we committed to the Cool Water 1000 T/D Texaco Partial Oxidation Gasifier, we and Texaco operated two 15 T/D small pilot plants for 15-20 years on coal water slurries. The technology was then scaled to 165 metric tons per day capacity, including waste heat recovery equipment, and operated at Oberhausen-Holten, Federal Republic of Germany for three years prior to our finally committing to the technology. In parallel, basic research work was being conducted at the bench scale, analytical characterization of the process under steady state and transient conditions was performed, and a thorough reliability and

availability analysis was conducted to define the necessary sparing philosophy at Cool Water. There is no substitute for a deliberate, systematic carefully controlled and managed technical development program prior to selecting demonstration plant/technology candidates.

I believe the experience summarized for the Texaco partial oxidation of coal in the preceeding paragraph should be used as a model for carefully assessing the technical readiness for new advanced coal technologies. Engineering and economic analyses of the competing technologies should also be conducted to determine whether the technology will be economically competitive, if we are technically successful. Additionally, alternate technologies should be compared to assess other benefits which they may provide, for example, ability to meet tighter air emission control requirements, minimize solid waste disposal requirements, or other potential benefits.

I also refer you to the Evaluation Criteria in Section 3 of my testimony. If these criteria are carefully and consistently applied, the Clean Coal Program should have a much greater probability of success.

6. What is the justification for multiple demonstrations of the same or similar technology?

A program oriented toward demonstration of competitive technologies, whether of the same technology or meaningful alternative, should be a primary objective. This approach will provide the electric utility industry the opportunity to negotiate the best approach for their particular system. In addition, each process choice, e.g., Texaco, BGC-Lurgi, or Shell has varying capabilities and limitations. For example, Shell can handle sub-bituminous coals and lignites as well as bituminous coals; however, its present state of development is approximately ten years behind Texaco and five to seven years behind BGC-Lurgi, both of which operate best on high sulphur bituminous coals. Again we do not want the utility industry to be forced to rely on only one supplier.

In the longer term, good competition will force each respective process developer to make improvements/cost reductions in his technology in order to retain a market share. The utility customer benefits from lower cost

electricity and the utility benefits from lower cost and design simplification.

Therefore, I strongly urge that a range of competitive technologies be developed and demonstrated to produce a truly meaningful set of clean coal technologies for use by the electric power industry.

THE ESSENTIAL FEDERAL ROLE IN COAL TECHNOLOGY R/D&D

Dwain F. Spencer
Vice President, Advanced Power Systems
Electric Power Research Institute
Chairman, Synthetic Fuels Research Institute

I. INTRODUCTION

Over the last ten years, the Electric Power Research Institute has defined, developed, and participated in a broad range of advanced coal technology developments, and most particularly research, development, and demonstration of numerous synthetic fuels from coal technologies. During this period, EPRI has cooperated closely with various federal government entities and Congressional committees to help ensure the selection of meritorious projects and to enhance the technical quality of the process developments during implementation of these projects.

Without attempting to provide a comprehensive list of our joint activities with the federal government, I would like to identify a number of representative projects including the Cool Water Coal Gasification Combined Cycle Plant, the Wilsonville Two Stage Liquefaction Pilot Plant, the H-Coal and Exxon Donor Solvent Coal Liquefaction Pilot Plants, and the Homer City Coal Cleaning Test Facility, which serve as the basis for my views. As a result of participating in these projects, we have had an opportunity to assess the importance and need for federal government support for emerging coal technologies. Let me state unequivocally that a federal government role is essential to bring advanced coal technology to early commercial realization.

II. THE PRESENT SITUATION

As we attempt to assess the importance of a federal role in coal technology R/D&D, it is imperative that we consider some of the key factors relating to the need for these technology options. Since I am most familiar with the needs of the electric power industry, I will focus my remarks on those needs. We are all aware that the major stimulus for advanced coal technology is the emission control requirements being levied or considered by the federal government.

Since passage of the Clean Air Act in 1963, and associated amendments in 1970 and 1977, control of SO , NO , and particulate emissions from large fossil fired generation has become a requirement. The requirements of the 1977 legislation to preserve air quality included regulations for Prevention of Significant Deterioration and Non-Attainment. The structures of the Clean Air Act reflect Congressional intent to combine two general approaches to air pollution control, a goals-oriented approach and a technology-based approach. The goals-oriented approach is directed at maintaining specific ambient air concentrations of certain pollutants and is embodied in the National Ambient Air Quality Standards (NAAQS). The technology-based approach is directed at limiting air pollution at the source and is manifested in the National Emission Standards for Hazardous Air Pollutants (NESHAPS) and the New Source Performance Standards (NSPS), Prevention of Significant Deterioration (PSD) and Non-Attainment (NA) regulations. Under certain conditions, each of the NSPS, PSD or NA regulations may be the controlling regulations for a power plant. During the eight years since passage of the CAA Amendments of 1977, a significant percentage of new steam electric power plants have been permitted at NSPS emission limits. However, the potentially more stringent PSD requirements can be the controlling regulations depending upon the policy of the permitting authority and specific State Implementation Plan (SIP) requirements.

A key controlling element of the CAA of 1963 and associated amendments is the restriction of emissions from new coal fired plants to ten percent of the SO_2 from the coal plant or a maximum of 1.2 pounds of SO_2 per million Btu (or lesser controls where the coal sulfur content is lower). However, there remain over 200,000MWe of old coal fired power plants which exceed these emission limits by varying degrees. It is the emissions from these older power plants that has been the focus of various forms of so-called "acid rain" legislation which would require further SO_2 emission reductions by six to twelve million tons of SO_2 per year by the mid-1990s. Without discussing all of the pros and cons of the situation, suffice it to say that the threat of this legislation becoming law is a major source of concern to electric utilities, as well as a major uncertainty in their ability to plan for the future. In my judgment, the requirements of such a law which likely would require "scrubbers" to be added to many existing coal fired plants, could be counterproductive to the environmentalists interests in the long run. A policy which enables the utility industry to substitute new more advanced control technology options for new coal based plants in the mid to late 1990s would seem much more amenable to long term control of undesirable emissions.

In addition to the CAA requirements, the Clean Water Act (CWA) of 1977 is the basis for regulation of liquid effluents from power plants. The discharges from new power plants are controlled by NSPS requirements which limit concentrations of specific pollutants from these plants.

Finally, the Resource Conservation and Recovery Act (RCRA) of 1976 is the basis for regulation of utility solid waste streams. RCRA provides two mechanisms for identifying hazardous wastes. The first mechanism defines hazardous wastes on the basis of characteristics including: Ignitability, corrosivity, reactivity, or toxicity. The second mechanism, listing, identifies wastes considered hazardous due to chronic effects. Toxicity is the primary question in classification of solid wastes from coal combustion or coal conversion processes.

Regardless of the ultimate classification of utility solid wastes, as hazardous or non-hazardous, regulations evolving under RCRA will have a considerable impact on the utility industry. Increasing stringency of federal requirements for non-hazardous waste disposal will increase solid waste disposal costs substantially for wastes such as scrubber sludge, bottom ash, or bottom ash and limestone.

In light of these major requirements for control of pollutants to protect the general public's environment, it seems only appropriate that the federal government assist the industry in developing advanced control technologies to deal with these emissions.

Table 1 provides a comparison of air emissions and solid wastes from various types of coal-based power plants from conventional pulverized coal plants with and without scrubbers to Integrated Gasification Combined Cycle (IGCC) power plants and Atmospheric Fluidized Bed Combustion (AFBC) power plants. It is clear from Table 1 that IGCC power plants offer major air emission control advantages over all other systems, and the solid wastes from IGCC plants are greatly reduced in comparison with pulverized coal plants with scrubbers or AFBC plants. Thus, it is clear that IGCC plants offer environmentally superior performance in utilizing coal for power generation.

But, what has the federal government done relative to fossil and synfuels R&D expenditures? It has drastically reduced its financial commitment to advanced technologies over the last few years relative to private sector expenditures. As an example, the results of the recent Synthetic Fuels Research Institute (SFRI) survey of synfuels related R&D efforts indicate that the ratio of spending by the federal government to the private sector

Table 1

Typical Effluent Streams
From Coal Based Power Plant Types
(Using 3.5% S. Illinois Coal)

Plant Type	SO_2 Emissions (Tons/MWe Yr)	NO_x Emissions (Tons/MWe Yr)	Solid Wastes (Tons/MWe Yr)
Pulverized Coal Plant (Precipators Only)	140	25	240
Pulverized Coal Plant With FGD (90% Removal)	14	8	750
Integrated Gasification Combined Cycle Plant	0.14-4	3	300
Atmospheric Fluidized Bed Combustion	7	4	1200

has fallen from 1.4 to 1 in 1979 to a projected 0.26 to 1 by the end of 1985. Although private sector spending on synfuels has remained essentially constant (or increased a little), the federal government program has been reduced by over a factor of 5. A correction to this trend is clearly necessary, if the utility industry is to be in a position to meet the ever increasingly stringent emission requirements with meaningful technological alternatives.

III. LESSONS LEARNED

As indicated earlier, EPRI has worked very closely with numerous federal government bodies including the Department of Energy, the U.S. Synthetic Fuels Corporation, and the Environmental Protection Agency over the last ten years to further the development of advanced coal technology to limit emissions from fossil-fired electric power plants. These programs have ranged from development of various options at the laboratory scale of experimentation to a few full scale module test and evaluation projects. However, during this period, successful research and development activities have brought a broad range of direct coal combustion systems and synthetic fuels technologies to the point where full scale module test and evaluation is now appropriate and necessary.

Based particularly on our experience in developing the financing arrangements for the 100MWe Cool Water coal gasification combined cycle project, we have learned some extremely important lessons relating to the importance of federal government support for such projects, namely,

1. Since these first of kind, full scale modules are not cost competitive with commercially available systems, funding commitments, or subsidies, are required not only for plant engineering and construction (capital) but also to subsidize extended plant operations (for periods of at least two and up to ten years).

2. The conduct of such full scale test and evaluation programs on full scale modules of new technologies, considering present U.S. energy costs, clearly requires some type of federal government assistance, in the form of capital and/or an operating cost subsidy.

3. Even with revenues from the kilowatt hour sales from such plants which are "close to being economically competitive", operating costs (and capital recovery requirements) will significantly exceed revenues during the first few years of operation.

4. Federal government commitments, once made, need to be honored over periods of 5-10 years if developers are to be confident that the government is a "reliable partner".

5. Selection of those technologies to be demonstrated at large or full scale should be made by the private sector, in conjunction with the federal government (or its bodies such as the SFC), to maximize the probability that commercial versions of these systems will be economically viable. Private sector proprietary rights and ownership should be protected, while providing royalty income or other partial or total cost reimbursement to the government as well as other partners from commercial plants, or from a follow-on commercial operating phase from a plant such as Cool Water.

6. Private sector cost sharing of at least fifty (50) percent should be required for full scale module projects to demonstrate the private sector commitment to the technology and to minimize taxpayer exposure to demonstration of commercially unattractive technologies, i.e., "we should put our money where our mouth is".

7. Planning and implementation of a program to demonstrate a broad range of advanced coal technologies should be undertaken now to assure that these systems, or at least some options, will be available for commercial introduction in the 1990s.

IV. SUMMARY

With the ever increasingly stringent federal emission control requirements being placed or considered for coal based power plants, it is clear that advanced coal technology is necessary to make these plants economically viable as well as environmentally acceptable. In order to provide the utility industry with a range of options to achieve these requirements, a federally sponsored assistance program in coal R/D&D is essential. This program must include both capital and operating support provisions to be effective in stimulating the full scale testing of the most technically, economically, and environmentally sound options. EPRI and the electric utility industry stand ready to work effectively with the federal government to achieve this important national objective.

Follow-up Questions to Clean Coal Technologies Coalition

Senator Domenici

1. How do we know that utilities will use new technologies to replace old plants in the 1990's? We may be making a substantial commitment of tax payer funds for something utilities will ignore.

The high capital and operating costs of the present generation of scrubbers are an obvious disincentive to the replacement of old, poorer controlled plants by new, better controlled plants. To the extent that more economical clean coal technologies can be developed to meet new source performance standards (NSPS), they will provide utilities with an incentive to retire plants earlier than would otherwise be the case.

With respect to improved technologies that fall short of meeting the NSPS, but that nevertheless are significantly more economical than the present generation of technologies, it is clear that they will have extensive application in the retrofitting of existing plants. In some instances such retrofits will be made voluntarily. In other instances, they will be compelled by a multiplicity of potentially changing statutory or regulatory requirements, i.e., acid rain control legislation, the pending court proceedings involving Clean Air Act §115 and §126, U.S. EPA's stack height regulation, etc. The point is that new, more efficient and more economical clean coal technologies will not be ignored. To the contrary, they will have extensive application both to new and to existing power plants.

2. The high degree of risk associated with the utility industry's financial commitment to commercialization of clean coal technologies has been cited as a major reason and need for government involvement in this program. Could you help the Committee better understand why utility industry investment in these

technologies is any different than the risk exposure of other industries seeking to bring these technologies into the marketplace?

As regulated enterprises, utilities are not permitted to realize entrepreneurial gains. Other, unregulated industries are better positioned to accept major risks because successful development translates into substantial profit potential.

3. The ERAB panel said almost all old plants will simply be refurbished so as to avoid large investments in plants which would be required to meet New Source Performance Standards, unlike the old ones which are grandfathered. Could you comment?

Undoubtedly utilities will attempt to extend the life of existing generating units because generally refurbishment is less costly than new construction. However, there is a question how long the economic life can be extended. All facilities eventually reach a point where it becomes impractical to continue to maintain them. At best, refurbishment will offer some delay in the need for replacement plant, but not preclude it. (See also response to Question 1.)

4. If the state PUC's are the impediment then why not seek changes at the regulatory level?

State regulatory agencies are under great pressure from consumer groups to keep utility rates just as low as possible. There are 50 separate state regulatory jurisdictions. While it is possible that a few state commissions might respond favorably to new capital commitments that would have the effect of increasing utility rates, I believe that this would be the exception rather than the rule. Also, those states that decline to remove impediments would be able to take advantage of the

technological developments paid for by the utility ratepayers in other states. This would be unfair. As a practical matter, federal assistance, which would be national in scope, is required.

5. You conclude that there will be insufficient supply to meet the demand for electricity in the mid-1990's. Does your analysis include the assumption that ERAB says is likely, namely, that most older coal plants will not be retired but will be refurbished?

Chart 2 to my filed testimony shows shortages developing in the mid-1990s without any retirement of existing plant. Chart 3 includes possible cancellations and retirements. The conclusion to be drawn is essentially the same in each case, that is the probability of capacity shortage by the mid-1990s.

6. You suggest in your statement that a clean coal technology program is an option to a regulatory one to reduce emissions further. Given that the regulatory program has not worked for some utilities, why should we believe a clean coal technology program will? Should all tax payers pay for the non-compliance of a few utilities?

I believe that the Clean Air Act has worked remarkably well. SO_2 emissions nationally have declined by 28% since 1973 and electric utilities have reduced their emissions by 19% despite a 60% increase in coal consumption during that period. (My company, for example, has reduced its SO_2 emissions rate by about 30% since 1970.) Our nation expends $25 billion annually on air pollution control. Therefore, I do not understand the statement that "the regulatory program has not worked for some utilities." I believe that it has worked exceptionally well and has accomplished astonishing results, e.g., only a handful of highly urbanized air quality control regions are presently non-attainment for SO_2, and particulate non-attainment--where it

exists today--is due almost exclusively to fugitive dust rather than to smoke stack emissions. I sincerely believe that a clean coal technology program also can work and will prove to be a cost effective supplement to an already effective regulatory program.

Regarding the last sentence of the question, I do not believe that non-compliance is an issue here. I am not aware of any significant or widespread non-compliance with existing law or regulations, and failure to meet the requirements of some possible future law, e.g., acid rain control, can hardly be characterized as "non-compliance."

7. Are you concerned, as DOE is, that DOE support for clean coal technology will subvert free market signals?

I do not believe that federal funding support for clean coal technology through the demonstration plant stage will send improper "free market signals." Federal support money in many instances may be absolutely essential if technological development is to occur. DOE management of funding support can encourage promising technological development if properly administered to avoid skewing such support in favor of one or more types of technology.

8. DOE has said that their previous assistance programs for projects have failed. Do you share that opinion? How could we make a clean coal program better?

I am not conversant with the past experience of DOE, but I do believe that, if a sharing of costs is required, those with a significant private commitment would do their utmost to obtain the maximum benefit from the combined resources.

9. What is the justification for multiple demonstration of the same or similar technology?

Needless repetition should, of course, be avoided but, if there are legitimate differences in approach toward proving a specific technology, consideration should be given to providing a demonstration of each such an approach, just as consideration is given to competing technologies.

Senator Ford

1. Mr. Disbrow, in your testimony you discuss the projected electrical capacity needs during the 1990s. I note from the charts attached to your written statement that a 2.5% growth rate in electricity demand could result in capacity shortages by the early 1990s, is that correct?

It is correct that shortages of generating capacity are probable by the mid-1990s should annual growth in peak demand average 2.5% annually and the most recent forecast of the National Electric Reliability Council is for 2.5% growth for the period 1985-1994.

2. If this projection of demand is accurate am I to understand that parts of the country may require additional electrical capacity in the early 1990s that is not currently planned or under construction? Also, you note in your testimony that 7 to 10 years are required to plan, construct and place into operation new base load powerplants. Can you tell us whether the utility industry has those additional units planned to meet the mid-1990 possible shortfalls?

It is very likely that a number of regions of the country will require additions to generating capacity beyond those currently planned. Furthermore, given the seven to ten year lead times for conventional base load generating units, commitments for new facilities must be made promptly to meet the needs of the mid-1990s and beyond. Absent such commitments, the alternatives will be additions of short lead time units, such as gas turbines, or shortages. Gas turbines, while sometimes attractive for peaking purposes, are not economic as a substitute for base load generation.

3. If utilities are not likely to undertake new construction projects how will the development of clean coal technologies help us meet any future capacity shortfalls?

Protracted shortages of generating capacity will be unacceptable in economic terms and there will be additional construction when the public and regulators respond to pending

or actual shortages by making it financially feasible for the industry to undertake major construction projects.

Technological development takes time and, even on the most optimistic timetable, promising clean coal technologies will not be ready for commercial application until the late 1990s. This would make them available in a period when it is quite clear that construction of new generating facilities will be essential.

4. What is the effect on developing clean coal technologies of requiring scrubbers on all new coal powerplants?

The development of clean coal technologies offers an alternative to scrubbers on new power plants at, hopefully, lower cost and improved operating efficiencies, while avoiding the inherent difficulties with flue gas desulfurization systems.

5. What would be the effect on developing clean coal technologies of requiring scrubbers on existing coal powerplants?

If scrubbers were mandated for existing power plants, control technology would be frozen at its present generally unsatisfactory level and the development of new, more efficient, and more economic technologies would be stultified for several decades.

While scrubber performance has improved during the past 15 years, scrubbers are still extremely costly to build and to operate. Their complexity results in periodic breakdowns. Furthermore, they generate enormous amounts of waste sludge which must be disposed of in an environmentally acceptable manner. The utility industry regards scrubbers as an interim--but, hopefully not as a permanent--solution to SO_2 emission control.

The cost of retrofitting existing plants with scrubbers would be so great that little would remain to fund further technological development. Also, having retrofitted new scrubbers onto old plants, the utilities would have little incentive--even if they had the funds--to engage in further control technology development for the foreseeable future.

6. If this Congress enacted legislation requiring a 12 million ton reduction in SO_2 emissions by the early 1990s, what would be the effect on developing clean coal technologies?

A 12 million ton reduction could be achieved today only by the en masse retrofitting of existing plants with scrubbers having removal efficiencies in the range of 90%. The effect upon emerging clean coal technologies would, therefore, be essentially the same as that described in my response to the previous question, i.e., stultification.

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202/662-8935

DAVID O. WEBB
Senior Vice President
Policy and Regulatory Affairs

November 8, 1985

The Honorable Pete V. Domenici
United States Senate
SD-434 Senate Office Building
Washington, D.C. 20515

Dear Senator Domenici:

I have attached GRI's answers to the Energy Research and Development Subcommittee members' questions on my May 16 testimony concerning "Emerging Clean Coal Technologies." Thank you for the opportunity to include these comments in the printed hearing record.

If you have additional questions, please contact me.

Sincerely,

David O. Webb

David O. Webb

Attachment

RESPONSE TO QUESTIONS SUBMITTED
ON OCTOBER 15, 1985
BY THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON ENERGY AND NATURAL RESOURCES

Questions from Senator Ford:

1. You set forth your recommendations on page 12 of your testimony. One of your recommendations relates to actions by the Synthetic Fuels Corporation. Does the Corporation have the authority to carry out your recommendation #7?

   It is assumed that the Synthetic Fuels Corporation's Board could include a clause within their contracts to provide the capability for testing advanced technologies at the plant site in the future. This authority would fall under the general powers of the Synthetic Fuels Corporation in negotiating contracts found in Sec. 171 " . . . to make agreements and contracts with persons and private or governmental entities. . ."

2. What is the effect on developing clean coal technologies of requiring scrubbers on all new coal power plants?

   See answer to following question.

3. What would be the effect on developing clean coal technologies of requiring scrubbers on existing coal power plants?

   Combined answer to questions #2 and #3: GRI is currently restricting its clean coal research to flue gas cleanup. GRI has not done an analysis on the effects of scrubbers on developing clean coal technologies. It is suggested that if scrubbing is required, then there would be little interest in developing clean coal technologies since the installation of scrubbers involves a large capital investment. The use of clean coal technologies has the potential of providing a much less costly solution to the problem of environmental pollution than scrubbers, but if scrubbers are mandated, there is no incentive to spend funds and make investments to develop and install clean coal technologies.

4. If this Congress enacted legislation requiring a 12 million ton reduction in SO_2 emissions by the early 1990s, what would be the effect on developing clean coal technologies?

   (A) It would increase the importance of clean coal research and development as a least cost technology option to meet new requirements; (B) it may be possible to reach that goal through the use of clean coal technologies; and (C) the timing of the reduction is critical in relation to the development of clean coal technologies and their entrance into the marketplace. Two past examples are the Exxon Donor Solvent coal liquefaction plant and several of the DOE-sponsored fluidized-bed demonstrations.

Questions from Senator Domenici:

1. Does the Fuel Use Act present any restrictions on the possible use of natural gas reburn technology?

   In most cases it would not. Under the provision for permanent exemptions for certain mixtures containing natural gas or petroleum, a major fuel-burning installation can use up to 25 percent natural gas. Less than 25 percent natural gas is needed in the gas reburn technology.

2. Would the repeal of the Fuel Use Act speed the clean-up of our air?

   Yes. It would give industry the option of burning a clean fuel (natural gas) in combustion turbines and combined-cycle applications to produce electricity. It would also increase the select use of natural gas with other fuels to meet clean air standards.

3. In your work with EPA on the Limestone Injection Technology, have you gotten any indication why they would essentially stop a demonstration of the technology by failing to give an exemption to the New Source Performance Standards for that project?

   No. While GRI's contractor is also a contractor with EPA on the LIMB technology, the bulk of GRI's contact with the contractor has been in the reburn technology area. Information has been exchanged in both technologies, but the issue of exemptions for New Source Performance Standards has not arisen in this particular case.

4. Burlington Northern Railroad is doing a demonstration of a natural-gas-powered locomotive. Why haven't they pursued a coal-fired locomotive demonstration?

   While GRI is aware of Burlington Northern's demonstration, we do not have knowledge of their internal decisions.

5. Are you concerned, as DOE is, that DOE support for clean coal technology will subvert free market signals.

   No. If the projects are handled correctly, there should not be a problem. As long as private industry is involved in both the cost-sharing and the management of the demonstrations, there shouldn't be a problem.

6. DOE has said that their previous assistance programs for projects have failed. Do you share that opinion? How could we make a clean coal program better?

   With a few exceptions, DOE has not been particularly successful in their assistance programs. However, if industry is involved in the cost sharing (at least 50 percent) and if the industrial partner is responsible for the day-to-day management of the project, this problem should be overcome.

7. What is the justification for multiple demonstrations for the same or similar technology?

   The same technology is often appropriate for more than one application. In addition, different sizes, configurations, and applications can yield valuable information in the operation of a technology. It must be remembered that no single technology will solve the problem of clean air because of the many different applications involved. Also, the multiple demonstration of the same technology has the potential to reduce risks and to involve several utilities in the projects, thereby providing a market for the technology if it is successful.

APPENDIX II

Additional Material Submitted for the Record

STATEMENT OF

THE AMERICAN GAS ASSOCIATION

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

ON EMERGING CLEAN COAL TECHNOLOGIES

May ~~29~~ 16, 1985

The American Gas Association (A.G.A.) is a national trade association comprising nearly 300 natural gas distribution and transmission companies serving more than 160 million consumers in all 50 states. Collectively, these companies account for nearly 85 percent of the nation's total annual gas utility sales.

A.G.A. is pleased to submit this statement on emerging clean coal technologies. Although we are not in a position to propose specific projects, we would like to be certain that this Subcommittee is aware of new technologies that could be funded from the Clean Coal Technology Reserve and that either: (a) combine the use of natural gas with coal to reduce emissions; or (b) otherwise help to utilize coal in a more environmentally attractive manner.

NECESSITY FOR FEDERAL INCENTIVES

In its Report to Congress on Emerging Clean Coal Technologies, the Department of Energy (DOE) recommended

55-031 O - 85 - 7

that the Federal Government should not provide incentives (i.e., loan guarantees, cost sharing, etc.) for emerging clean coal technologies. The DOE determined that free market forces will "select and commercialize the most efficient and environmentally-effective technologies for processing and using coal . . . ." The DOE further stated that Federal incentives would only interfere with the operation of market forces and could affect adversely the development of nonsubsidized technologies.

A.G.A. does not believe that Federal incentives would interfere with the commercialization of these technologies. Although free market forces will ultimately determine which of the emerging coal technologies will be best suited for commercialization, substantial expenditures will be necessary to develop these technologies prior to commercialization. Federal incentives are necessary to develop and demonstrate the potential for these new technologies: i.e., to bring them to the point at which the market can choose between them.

As a related point, regulatory policies often constrain rate-regulated gas and electric utilities from gambling on a promising new technology. These regulated companies frequently need to share risks with governmental agencies until the new technology is proven through experience with pioneer plants.

A.G.A. also disagrees with the DOE's suggestion that past experiences with Federal assistance in the development

of new fossil technologies has been completely unsuccessful. A recent and prominent example is the Cool Water plant in Daggett, California. This small-scale powerplant produces on-site medium BTU coal gas at a rate equivalent of 1000 barrels of crude oil per day for use in combined cycle power generation. Although Federally assisted, the project has reportedly been so successful that it is now emerging as a possible model for large-scale private sector efforts.

SELECT GAS USE

Select gas use (select use) refers to a relatively new concept in fuel combustion: the burning of natural gas with less environmentally attractive fuels in the same or separate combustion units for environmental control purposes. Natural gas combustion emits virtually no sulfur dioxide or particulate matter, and far less nitrogen oxides, nonmethane hydrocarbons and carbon monoxide than other fossil fuels.

As one option, select use may involve the combustion of gas and another fuel (most often coal) in the same combustion unit as a fuel mixture. A more common approach, and less difficult from an engineering perspective, involves the concurrent combustion of gas and some other fuel in separate combustion units, with subsequent averaging of the emissions from the two sources. This latter approach (termed a bubble), when approved by the Environmental Protection Agency (EPA), may be used to meet the air quality

guidelines of a State Implementation Plan (SIP). A third approach (not currently sanctioned by the EPA) entails the seasonal substitution of gas for other fuels. Coal or high-sulfur oil could be burned for a portion of the year and natural gas could be burned for the remaining portion of the year to offset the coal- or oil-derived emissions.

These concepts have advanced from the theoretical stage to the implementation stage. More than two dozen select use applications have been implemented, including four cases of concurrent combustion in a single unit. Furthermore, at least four major institutions are conducting additional research into the simultaneous combustion of gas and other fuels in a single unit. The research relating to gas and coal combustion is focused in three areas: (1) reburn technology to reduce NO_x and SO_x emissions; (2) gas use to assist the burning of coal-water mixtures; and (3) gas use to assist oil-to-coal conversions (utilizing either coal-water or dry coal).

(1) Reburn Technology

Reburn is a post-combustion pollution control method that can be used to reduce NO_x levels found in the combustion products of coal-fired electric utility or industrial boilers. Natural gas (or another fuel) is injected into the exhaust from a coal-fired boiler, creating a fuel-rich zone in which the NO_x reacts and produces free nitrogen; air is then added to complete the combustion

process. Preliminary testing indicates the reburn process using gas could easily reduce NO_2 emissions by 50 percent. The Gas Research Institute and the Energy and Environmental Research Corporation are currently conducting research on the reburn process to determine: (a) how close the reburning fuel should be relative to the combustion zone; and (b) how much time should be allowed for reburning before air is injected into the process.

(2) Assisting Coal-Water Mixtures

Coal-water mixtures were originally proposed as a way to displace foreign oil with domestic coal. More recently, however, it has become evident that coal-water mixtures may appeal to those who use coal but want to avoid the environmental impact associated with the direct combustion of dry coal. One reason for this expanded market for coal-water mixtures is that developers of such mixtures have been developing innovative methods for cleaning the coal before it is integrated into a mixture. Unfortunately, the use of coal-water mixtures may lead to substantial deratings, slagging, fouling, flame instability and other problems. Recent gas industry sponsored research indicates, however, that cofiring coal-water mixtures with natural gas offers an economic and environmentally attractive solution to these problems. We cite as examples three recent papers:

(1) J. Dooher, T. Kanabrocki, and D. Wright, Co-firing of Coal Water Slurries with Natural Gas, (Adelphi Center for Energy Studies, Adelphi University, Garden City, New York).

(2) Robert H. Essenhigh, E.G. Bailey, Kyu-il Han, and Zongwen Li, Performance Characteristics of a Hot-Wall Furnace Fired With Coal Water Slurry (CWS) Using Gas/Air Atomization (The Ohio State University, Columbus, Ohio).

(3) Alex E.S. Green, Coal-Water Mixtures - A Market Opportunity for Natural Gas (University of Florida, Gainesville, Florida).

(3) Oil to Coal Conversions

In addition to the use of coal-water mixtures, economically and environmentally advantageous conversions of oil-fired boilers to coal have been proposed using a precombustor/ash separator unit. A research team at the Unversity of Florida is currently using natural gas to assist a full scale oil to coal conversion. We cite for example:

(1) A.E.S. Green, An Alternative to Oil: Burning Coal with Gas (Gainesville, FL, University Presses of Florida, 1981).

COAL GASIFICATION

Gasified coal can be combusted without the adverse environmental impact associated with direct combustion of pulverized coal. A coal gasification plant gasifying western coal produces from 5 to 58 percent of the air pollutants emitted by a coal-fired electricity generation plant with scrubbers. Furthermore, a coal gasification plant emits only 40 percent of the solid wastes produced by a coal-fired electricity generation plant.

Funds from the Clean Coal Technology Reserve could be used to promote second- and third-generation gasification processes. We view as particularly promising the U-Gas technology (which was developed by the Institute of Gas Technology and would have been demonstrated commercially if the Memphis onsite medium Btu coal gas project had received Federal assistance and become operational); the Kellogg-Rust Westinghouse (KRW) technology (which is currently being utilized at a Pennsylvania test facility that receives both industry and government support); and any other technology which entails ash agglomerating fluidized bed gasification.

It is the considered opinion of our Coal Gasification Subcommittee and Advanced Technology Task Group that these second-generation technologies -- when compared with the currently available Lurgi technology -- could potentially reduce unit production costs by at least 20 to 25 percent. In addition, our most knowledgeable member company advisory groups are convinced that second-generation technologies could also reduce substantially the environmental impact of currently available coal gasification technologies.

Additional research facilities for these technologies, such as a test facility that we propose to site at the Great Plains gasification plant, would be valuable. However, we also believe that the second-generation technologies are now ready to proceed to the stage of small-scale commercial projects.

PROJECT SELECTION PROCESS

The Environmental Policy Institute has suggested that funding recommendations for specific clean coal projects should be determined by the DOE, EPA, National Coal Council (NCC) and Electric Power Research Institute (EPRI). A.G.A. strenuously opposes the selection of coal projects by such an exclusive group of organizations. The NCC and EPRI represent narrowly focused interests whose primary research concerns may not encompass the vast array of clean coal technologies. For example, EPRI is concerned primarily with the development of coal technologies that can be used to generate electricity. Although we support clean coal research for electricity generation, we believe that clean coal research for purposes other than electricity generation would also serve the public interest. Research on select use and coal gasification would result in the development of both industrial and electric generation uses for coal that offer significant environmental benefits.

A.G.A. strongly recommends that decisions on specific coal projects be made by the appropriate government agencies and a broad-based consortium of energy research organizations representing all of the segments of the energy research community that are interested in clean coal research. A diverse group of organizations could determine by consensus the coal research that would most benefit the public.

CONCLUSION

A.G.A. believes that select gas use and advanced-generation coal gasification offer the potential for significant advances that will permit coal to be used in a clean, environmentally sound and cost-effective manner. We also believe that the process for selecting coal projects should reflect the consensus of the energy research community and the government on the coal research projects that would be in the public interest.

STATEMENT OF JOHN W. BOSTON
SENIOR VICE PRESIDENT
WISCONSIN ELECTRIC POWER CO.
TO THE
ENERGY RESEARCH & DEVELOPMENT SUBCOMMITTEE
OF THE SENATE ENERGY & NATURAL RESOURCES COMMITTEE
MAY 16, 1985

Chairman Domenici and members of the subcommittee, I am John W. Boston, senior vice president of Wisconsin Electric Power Co., Wisconsin's largest electric utility. We supply energy services to more than two million people in a 12,000 square mile service territory in both Wisconsin and Upper Michigan. I welcome the opportunity to provide this statement in support of the Clean Coal Technology program and the specific technology known as pressurized fluidized bed combustion.

I am sure you are all keenly aware of the important role that coal plays not only in the generation of electricity in the United States, but also in the economy of various regions of our country. Let me provide some additional perspective. The electric utility industry is and will continue to be the nation's major consumer of coal. By 1995, electric utilities are expected to account for 86 percent of total U.S. coal consumption. Coal will be used to generate 55 percent of total electricity produced in this country by 1995, up from 51 percent in 1980.

Coal from the Eastern and Midwestern United States has played a major role in meeting our energy needs. But its future and the jobs that go with it are clouded by uncertainty, as proposed restrictions on sulfur dioxide emissions could make Eastern and Midwestern coal less desirable.

At Wisconsin Electric, about 60 percent of our electricity comes from coal-fired generating plants. Fifty-three percent of the coal we use comes from Kentucky and Illinois. Ten years ago, 70 percent of our coal came from Midwest suppliers.

With electricity a major factor in economic growth, it is important that the nation's No. 1 fuel -- coal -- be given high priority when we make decisions about our economic future. Western coal will continue to be in demand because of its low-sulfur content. However, while our country's coal reserves are enough to last 300 years, the uncertainties that surround the use of higher sulfur coal have placed many of those reserves in doubt. They also have forced electric utilities around the country to seek more expensive alternatives. Those alternatives include the use of low-sulfur coal or the construction of power plants with expensive pollution control systems.

The uncertainties surrounding higher sulfur coals stem mainly from the public perception that acid rain is menacing our environment. The public is asking for two things -- first, a clean environment and second, adequate and economical supplies of electricity. The two concerns need not be in conflict.

Acid rain is a phenomenon that needs to be handled in a coordinated way, on a national and international basis, with the costs shared equitably. Earlier this year, Wisconsin Electric's Chairman, Charles McNeer, sent letters to all members of the Wisconsin congressional delegation, noting that Wisconsin Electric can and will support appropriate national legislation to address concerns about acid rain. I have attached a copy of one of those letters to my testimony here today. In it, he proposed that any national legislation be implemented in two phases. The first would set reasonable, cost-effective requirements to reduce SO2 emissions. The emission levels of the second phase would consider the measurable effects of phase one and take into account all of the research that is now starting to come together, along with the availability of the new clean coal technologies that are being developed.

Not only is our country involved in an acid rain debate that could limit our use of coal, we also find ourselves in an era when adding new nuclear power plants is not a practical option. Because of cost and regulatory uncertainty, the electric utility industry simply cannot plan today for additional nuclear plants. That establishes a persuasive case for the need to demonstrate practical clean coal technologies.

With the expected increase in the use of coal, it is even more important that we begin today to demonstrate these technologies so that we will have options available to us in the 1990s. Other options, such as scrubbers or the use of low-sulfur coal, are expensive, threaten the loss of thousands of jobs and represent short-sighted solutions to a long-term need.

That is why support for the Clean Coal Technology program is vital. That is why I ask your support for what I believe is the boiler of the future -- the pressurized fluidized bed combustion project that Wisconsin Electric has proposed to construct in cooperation with Foster-Wheeler Development Corp., Brown Boveri Corp., Gilbert/Commonwealth and Research-Cottrell.

Wisconsin Electric has a long and successful tradition of leadership in research and development programs for coal-fired power plants. Early in this century, we were the first utility in the world to burn pulverized coal for the generation of electricity, and we constructed the world's first plant built to burn pulverized coal exclusively. Our pioneering efforts in coal research led to world records in power plant efficiency.

We haven't ignored the customer side of our business. Wisconsin Electric has been a leader in successfully controlling increases in demand for electricity, and reducing the need for new power plants, through innovative conservation, rate design and load management programs. One measure of our success was our ability to reduce rates three times in the past 15 months -- a record unmatched by any major U.S. utility.

Our latest project -- the pressurized fluidized bed combustion system -- will reduce sulfur dioxide emissions by up to 90 percent -- even while using Midwestern coal. The system readily meets new source performance standards for nitrogen oxide emissions, and it has the potential of operating as much as 15 percent more efficiently than today's conventional coal-fired power plants. This along with the potential for shorter construction times and lower construction costs could effectively reduce electric energy costs to our customers. This revolutionary system can mean a strong future for coal mined east of the Mississippi River. It can mean a more economical electricity production. And it can mean a cleaner environment. We believe the PFBC boiler has the potential of being the boiler that could lead the utility industry into the 21st century.

Earlier this month, the U.S. Department of Energy sent its report to Congress on emerging clean coal technologies. Sadly, in that report the department recommended no federal incentives be provided for these technologies. It also stated that such incentives would not accelerate commercialization of these technologies and may be counterproductive to their development.

I am here today to respectfully disagree. At a time when our country needs to take action to become energy independent we need this federal support. And, at a time when many regions of our country need stable markets for use of their coals to spur their economies, we need this federal support.

Granted, the federal government cannot be expected to pay the entire bill for these technologies but no one is suggesting that.

However, as in the case of our PFBC proposal, neither can Wisconsin Electric ask its customers and stockholders to take on the sole responsibility for demonstrating the PFBC. Wisconsin Electric has begun its own ambitious national campaign to seek additional funds for our PFBC project from the coal and utility industry and others that would benefit from a demonstration of the commercial viability of the PFBC technology. This campaign will decrease the need for federal help but it will not eliminate it. The successful demonstration of our PFBC project will benefit the entire nation and as such should appropriately receive federal support.

Concerning DOE's statement that accelerated commercialization will not occur through these incentives and that such incentives may be counterproductive, I again respectfully disagree. The fact that many of these technologies were not committed to a demonstration phase by the private sector until the Congress offered the promise of some support gives some indication of how slowly these technologies would develop without that assistance.

Congress sent a message to the private sector when it approved the Clean Coal Technologies Reserve. That message said that the federal government would consider assisting worthy projects that would help keep our environment clean, lead to our energy independence and help strengthen our economy. Wisconsin Electric's PFBC proposal meets all three of those goals. I believe Congress would be sending the wrong message back to the people if it now changed its mind and decided to fund none of the projects.

Even the DOE's report underlines the significant contribution that the PFBC holds for our energy future. It states that the advantages of the PFBC are "high efficiency and superior environmental performance."

I believe the private sector has a responsibility to continue to develop these projects with or without federal help. However, I also believe that without federal help, many of these projects will either never be developed or will be pushed much further into the future. We no longer have that kind of time. I believe the hiatus in ordering new generating plans has about come to an end. Some electric utilities are beginning to plan for new facilities that will be needed in the mid-'90s.

A generating plant utilizing a PFBC boiler has the potential of meeting the future electric needs of this country, not only in an environmentally clean way but also in a more efficient and less costly way than today's current technology.

Our PFBC project is vital to the economic future of our country, and can help us maintain our energy independence. I urge your support for the Clean Coal Technology program and for the Wisconsin Electric PFBC demonstration project I have described.

Thank you for the opportunity to appear today.

Wisconsin Electric POWER COMPANY
231 W MICHIGAN, P.O. BOX 2046 MILWAUKEE, WI 53201

February 19, 1985

Senator Robert W. Kasten, Jr.
110 Hart Senate Office Building
Washington, D.C. 20510

Dear Senator Kasten:

The legislation proposed by the National Governor's Association offers the framework for a reasonable approach to the concerns about acid rain, but also contains provisions that would significantly increase the price of electricity in Wisconsin.

While I cannot support the NGA proposal as written, it does address some important elements that should be included in any national approach to this issue. Those elements are:

--a two-phase sulfur dioxide emissions reduction program;
--a first phase requiring reasonable reductions in sulfur dioxide emissions that can be obtained in a cost-effective manner;
--an expanded and accelerated research program;
--a second phase that would be implemented only if the research and an assessment of the first phase results demonstrate the need for more controls; and
--an implementation schedule for phase two that will allow for cost-effective advanced technologies for sulfur dioxide emissions reductions to become commercially available.

I should point out that the NGA bill is by no means the moderate bill some have suggested it is. In fact, it goes far beyond the issue of acid rain. It virtually requires a minimum 10-million-ton sulfur dioxide emissions reduction and it gives unprecedented decision-making power to the EPA administrator. These provisions make the bill unacceptable as a whole. Let me explain further.

As written, the NGA bill would likely force Wisconsin Electric to install scrubbers on one or more of our power plants in phase one. Rate increases of at least 10 percent would be necessary if these scrubbers are required.

An alternative that we favor would be first phase reductions on the order of three million tons of sulfur dioxide a year from 1980 levels, and flexibility for utilities in how they meet such reductions. This would allow us to avoid making huge financial commitments to retrofit older units with extremely expensive scrubbing equipment that may later prove unnecessary.

During phase one, we should proceed with an expanded research program that would be used along with the results on the phase one reduction program to determine whether it is necessary to proceed with additional controls. Reductions in the second phase should be tied to the demonstrated need for more controls and to the availability of cost-effective emissions reduction technologies.

The NGA bill takes the opposite approach. It says the second phase could be reduced or eliminated only if the EPA administrator convinces Congress that such a change will increase protection of resources. This is an impossible test. If the Congress is unconvinced, or if one tree or lake could be said to be potentially susceptible to damage, the additional phase two reductions must take place.

In addition, the bill authorizes the EPA administrator to further increase sulfur dioxide reductions and require nitrogen oxide emissions reductions in the second phase. He would have to explain to Congress only if he chose not to require nitrogen oxide reductions.

We believe decisions about implementation of the second phase, or about even more stringent emissions reductions, should be made by Congress, not the EPA administrator. These decisions should be based on technical, economic and public policy information. To leave such decisions in the hands of the EPA administrator, as the NGA proposes, authorizes an inappropriate exercise of the administrator's judgment and authority.

Equally troublesome is the fact that the NGA bill undermines the powers of the existing Clean Air Act, which is the vehicle already established by Congress for dealing with such issues as ambient air quality, health effects and visibility. The NGA bill's broad statement of purpose seems to empower the administrator to circumvent this vehicle and its well-established health and welfare standards.

Acid rain is a national issue, and as such should be dealt with on a national level. This bill, however, does so in an unacceptable manner. I urge you not to join as a co-sponsor of this bill until modifications are made.

Despite the national nature of the acid rain issue, Wisconsin has taken steps to reduce sulfur dioxide emissions. These actions include:

--state legislation placing a cap on utility sulfur dioxide emissions;
--new state Department of Natural Resources rules requiring further sulfur dioxide emissions reductions;
--a $1.7 million research project into the causes and effects of acid rain, conducted jointly by state agencies and utilities, with the utilities providing $1 million. This research so far shows no evidence of acid rain damage to lakes or forests in Wisconsin.

On its own, Wisconsin Electric recently has embarked on a revolutionary new sulfur dioxide emissions control project. We have indicated our desire to be the host site for a pressurized fluidized bed combustion (PFBC) demonstration unit at our Port Washington Power Plant. This unit could remove some 90 percent of the sulfur from the coal as it is burned, and could yield important data that would help bring such PFBC units to commerical availability.

I am concerned that in the absence of preemptive federal action, Wisconsin and other states will take further uncoordinated steps to independently reduce sulfur dioxide emissions. This would be counterproductive on two fronts. If Wisconsin acts alone in reducing sulfur dioxide emissions, those reductions would be so insignificant on a national basis that they would have no measurable effect, positive or negative, on the environment. And, by standing

alone to require emissions reductions, Wisconsin would put its businesses and its citizens at an economic disadvantage. Acid rain is a phenomenon that needs to be handled in a coordinated way, on a national basis and with the costs shared evenly.

Finally, while I don't mean to suggest that acid rain will just go away, there are several developments on the horizon that will help mitigate its effects. For instance, as older plants are retired, newer plants burning lower-sulfur coal will come on line. New sulfur and nitrogen oxide emission reduction technologies that can be retrofitted onto older units may soon become commercially viable. Given time, these two factors alone could make a big difference in the scope of the problem. This, combined with the expanded research program proposed by the NGA should make it easier for us to determine whether additional control measures are necessary.

This NGA bill also contains numerous other provisions that are objectionable and that I would be pleased to discuss with you in more detail. Do not hesitate to call.

Sincerely,

Charles S. McNeer

Chairman of the Board and
Chief Executive Officer

cc: Governor Anthony Earl
Secretary Carroll Besadny
Chairman Ness Flores
Commissioner Branko Terzic
Commissioner Mary Lou Munts

Statement of

Dr. Ronald J. Pugmire
Associate Vice President for Research
and
Professor of Fuels Engineering
University of Utah

and

Dr. John W. Jutila
Vice President for Research
and
Professor of Microbiology
Montana State University

Before the

Energy, Research, and Development Subcommittee
of the Senate Energy and Natural Resources Committee

May 16, 1985

I. INTRODUCTION

We are all familiar with the crisis atmosphere created by the Arab oil embargo in 1973 and the Iranian oil cut-off in 1979. With this crisis the government launched a massive research and development program aimed at developing alternative energy sources and fossil energy technologies.

Since 1981 the crisis period seems to have passed and we now have the choice of two paths to follow regarding alternative fossil energy resource development. The first is to once again entrust our energy future to the world marketplace and worry about any future crises when they arrive. The second path is to use the respite from an oil crisis to make the transition to a post-petroleum energy future as painless as possible by developing the expanded use of our coal resources.

The reasons for continuing efforts to utilize alternative fuels, such as coal and other fossil fuels sources, are many:

- The petroleum production capacity of the United States has not risen above the 8 to 8.5 million barrels per day plateau, in spite of a nearly 3-fold increase in oil well drilling over the past four years.

- While the recession fuel substitution and conservation efforts reduced liquid products demand from a peak of 16 million barrels per day to a low of 12 million barrels per day, the demand is again rising and is now about 15 million barrels per day.

- The curtailed consumption in the U. S. is due largely to a return to small 4 cylinder automobiles, insulation of buildings and the shutting down of high energy consuming industrial plants (the steel and copper industries and their satellites are not likely to recover), and substitution of coal for oil where feasible. These "belt tightening" efforts appear to be a one time phenomenon and may be approaching their economic limit.

- Oil and gas well-drilling efforts have brought into production many new gas (only) fields due to the incentive of the 15-fold increase in the well-head value of gas. However, in no year did the oil drilling efforts result in finding as much new oil as was used in the U.S. that year.

- Finally, there is about 20 times as much energy available from coal resources in the U.S. as either petroleum or natural gas. We need economically competitive coal-to-oil processes to control further escalation of foreign crude costs (as the world demand resumes its inexorable rise).

The U.S. possesses a huge recoverable coal resource of some 430 billion tons - representing enough energy to provide our entire energy needs for decades to come. Approximately 450 million tons of coal are consumed annually by the United States eastern regional utilities to produce over 200 GW of electricity. The direct combustion

of coal has been identified as a potential major contributor to the acid rain problem. The increased use of coal for electrical production is inevitable and the Department of Energy estimates that by 1990 over 50% of all electric power generation will come from coal fired power plants. Both national and international interest has been expressed publicly and legislatively in reducing the amount of sulfur oxides emitted into the atmosphere by combustion of coal. The development of clean coal technologies is critical to the resolution of the environmental problems associated with expanded coal combustion and concomitant requirements to meet new source performance standards.

One major limitation of near-term and existing clean coal technologies is their large capital costs. A typical retrofit of a coal powered generation plant with sulfur reduction technology is estimated to cost $120 million for a 200 MW facility. This estimate is for installation of a unit based on the limestone fluidized bed removal concept. If this cost is multiplied by the approximately 300 facilities in need of advanced sulfur removal technologies, a $36 billion investment is required to achieve low atmospheric sulfur emissions. Given the current economic climate, it will be extremely difficult to rapidly impact sulfur oxide emission via retrofit of existing plants. A rapid advance in technology is required to implement sulfur oxide reduction with a minimum capital investment for the utilities. Furthermore, coal processing plants in existence today were not built to produce super clean coal and trying to retrofit these plants is costly. Therefore, a research program directly aimed at developing technological concepts for super clean coal is needed today.

Most, if not all, of the potential second generation technologies which require minimal capital investment can be described as precombustion processes. Such technologies might include biological desulfurization, super critical extraction, membrane technology, advanced coal beneficiation, and computer control of process operations.

By the year 1990, 54 percent of the total electric power production will come from coal fired power plants. Hence, research in the areas of ultrafine grinding and ultrafine coal cleaning will be required. Needless to say, computer technology must be applied to the processing of coal to increase efficiency. All of these emerging technologies require significant research and development to transform them into mature concepts which can be applied commercially.

Vast coal resources are located in the western United States. In the Rocky Mountain and Great Plains regions, comprising the states of Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming, one finds approximately 50% of the recoverable bituminous and lignite coal in the U.S. This reserve base, together with a unique combination of institutional resources in the Rocky Mountain states, represents an opportunity to rapidly mobilize and develop these second generation technologies. The universities in this region--Colorado, Idaho, Montana, Utah, and Wyoming--have been historically active in coal technology development. A wealth of fundamental data and expertise on coal structure, composition, comminution, and related technology exists in these institutions. Centered both geographically and technolcgically among these univer-

sities is the Idaho National Engineering laboratory (INEL). Due to its long involvement with the nuclear power industry, INEL is intimately aware of the needs of electric power utilities. The coal resource and fundamental research resources of the area's universities, combined with INEL's diverse research capabilities, provide a powerful synergestic group to initiate a super-clean coal technology effort.

The goal of this effort will be to produce super-clean coals which meet the requirement of less than 1% total sulfur and an ash content of 1% or less.

A plan has been developed which will provide an organization to coordinate regional activities, a program structure, and research and development activities to dramatically advance state-of-the-art precombustion coal cleanup. The organization, strategy, and technology programs needed to bring this futuristic program to fruition have been defined. Programs to identify new areas of technology and to propel emerging technologies have been developed. This plan is structured to be consistent with the DOE Fossil Energy Advanced Research and Technology Development Program. The program objectives are: (1) to aid in the development of a regional program to develop second generation technologies for precombustion coal cleanup; (2) to provide an organizational framework through which regional universities and INEL can collaborate on this problem; and (3) to define components of the program. This further includes the creation of policy related to clean coal, support of research and development activities, and transfer of emerging technologies to industry.

II. RESEARCH NEEDS

The specific thrust of the proposed initiative is to dramatically advance the state of super-clean coal technology. The implied strategy is to develop existing but immature technologies and to provide new technologies for precombustion coal clean-up.

Initial efforts will use existing technologies, now considered undeveloped and unproved, as the base for coal cleanup technologies. However, to provide the types of technologies desired for implementation in the 1990s, long-range efforts must strive to create venture technologies which radically extend cleanup capability.

The initial coal cleanup research program concept is divided into three major categories: 1) characterization, 2) bioprocessing, and 3) coal beneficiation. The tasks presently envisioned in each category will be jointly performed by INEL and university scientists.

1. Coal Characterization

Coals are highly variable in their composition and character. As an "organic rock," the physical and chemical properties are a function of many variables including rank, botonical input, depositional environment of the original peat bog, mineral matter content, extent of weathering, etc. These factors can vary dramatically even within a given coal seam. The nature of the coal will have a profound effect on the particular technology being applied to reduce pollutants. An example of the diversity of coals within the Rocky Mountain coal province is provided in Figures 1-3. Using sophisticated analy-

tical tools and computer analysis techniques, coals from a five-state region (Figure 1) are shown to group not only by rank (Figure 2) but also by the nature of the carbon skeletal structure of the 100 coals analyzed. In order to devise adequate pre-combustion coal cleanup technologies, it will be necessary to adequately characterize the coal to be used for a given technology. Employing modern characterization techniques such as fourier transform infra-red, pyrolysis mass spectrometery, solid state NMR, etc., coupled with sophisticated computer assisted data analysis, the scientific basis of tailoring the nature of the coal to the coal cleanup technology may be possible.

2. Bioprocessing

Microorganisms collected from several natural sources have been found to digest both the inorganic (pyritic) and organic sulfur containing compounds found in coal. These organisms appeared to release this sulfur in a gaseous form that is easily removed from the coal and biological medium. Given the current state of genetic engineering, expression of traits such as digestion of materials has been enhanced as much as five times. A focused effort to enhance microorganisms which digest coal sulfur constituents could result in digestion rates sufficient to meet on-line demand rates of existing coal feed combustion. Work on digestion reactors that could be employed in unit operations would be a vital segment of this effort. Since biotechnology does not require significant energy input in the form of heat or expensive or caustic chemicals in order to remove sulfur (as required by existing coal washing technologies), biotechnology could play an important role as one of the advanced technologies needed to solve the acid rain problem.

3 Coal Beneficiation

Coal is ground to extremely fine sizes so that the ash can be released from the coal particles. Then, ash particles can be removed by subjecting the ground product in a suitable force field. However, grinding coal to extremely fine sizes requires expenditure of energy and an optimum size of the coal product must be defined. Modern techniques, including computerized image analysis, are well suited for this behavior of ultrafine particles in a suspension of water must be developed so that one can devise newer technologies for coal/ash separation. There are many concepts such as carrier flotation, fast-flotation, chemically enhanced flotation, etc., that are in the laboratory stage. All of these concepts must be carefully examined for technology development. Whatever technology is developed, in order to run a large-scale plant efficiently, one needs process sensors that are interfaced with a control computer for plant automation. This requires an investigation of the behavior of coal particles in magnetic, ultrasonic, X-ray and optical fields.

III. PROGRAM MANAGEMENT AND COORDINATION

The research and development needs outlined require the coordination of a diverse group of talented investigators in the physical, biological, engineering, and minerals sciences. Integrating the current knowledge base on coal and its properties, devising new coal cleaning concepts, carrying out laboratory proof of concept experiments, and transferring the technology to the industrial sector will require a major management effort. Such an effort is outside of

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the scope or mission of universities. A major government laboratory, such as INEL, is well organized and suited to such a role. In particular, INEL is located near the western universities where major coal research programs exist, is near the major western coal deposits, and has major research support facilities that will be of value to research teams at several of the area's universities. The close proximity of INEL to the major coal research programs in the west will facilitate faculty and student exchange with INEL personnel and facilities where appropriate.

As representatives of Montana State University and the University of Utah, Mr. Chairman, we endorse the initiatives of INEL to develop a cooperative research program in pre-combustion coal clean up with the universities in the western United States.

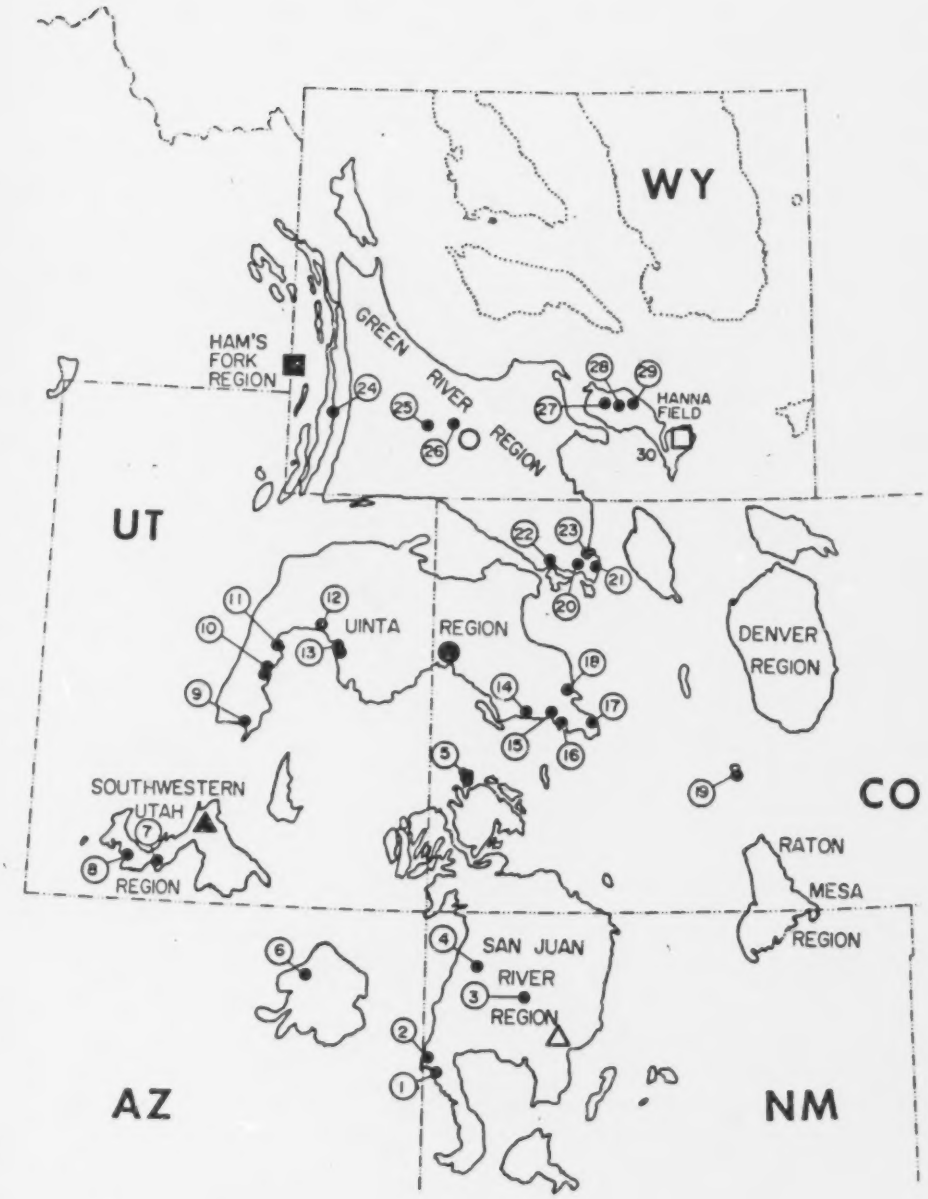

Figure 1. Geographical location of the main coal regions within the Rocky Mountain Coal Province.

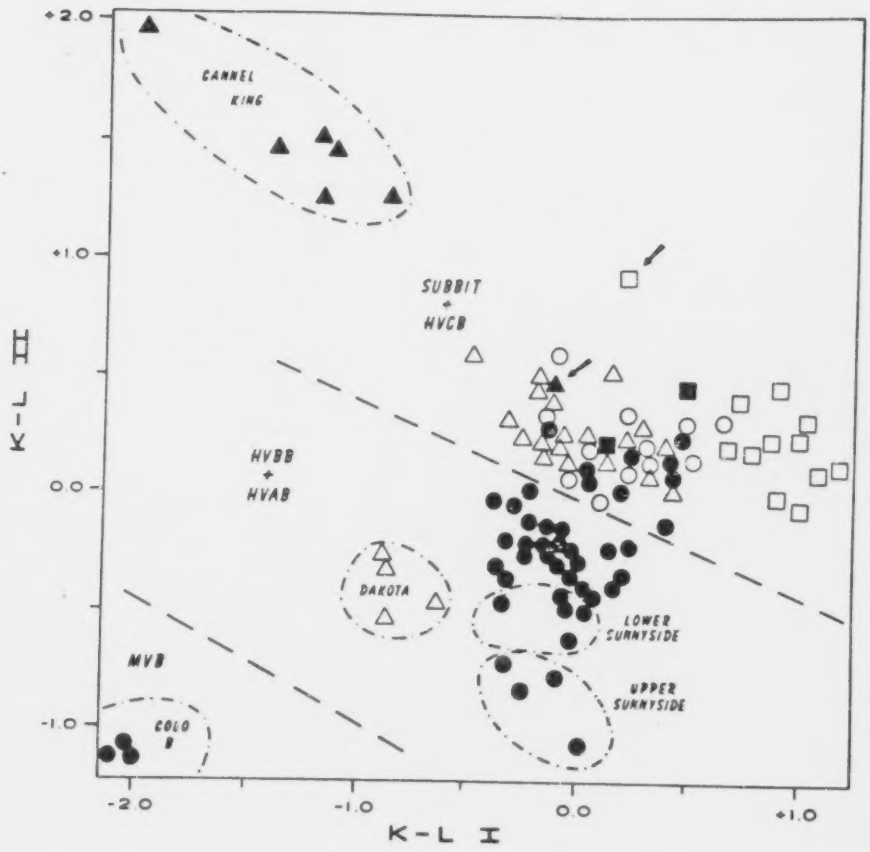

Figure 2. Karhunen-Loeve (K-L) projection of the factor scores for the first two factors of the full Py-MS data set (minus PSOC 161). Symbols used refer to coal regions within the Rocky Mountain coal province (see Figure 1). Note the obvious clustering of samples from individual coal seams as well as the overall rank tendencies with an obvious coalification "jump" between hvCB and hvBB ranks. Arrow points to lowest rank coal (PSOC 161; Subbit C).

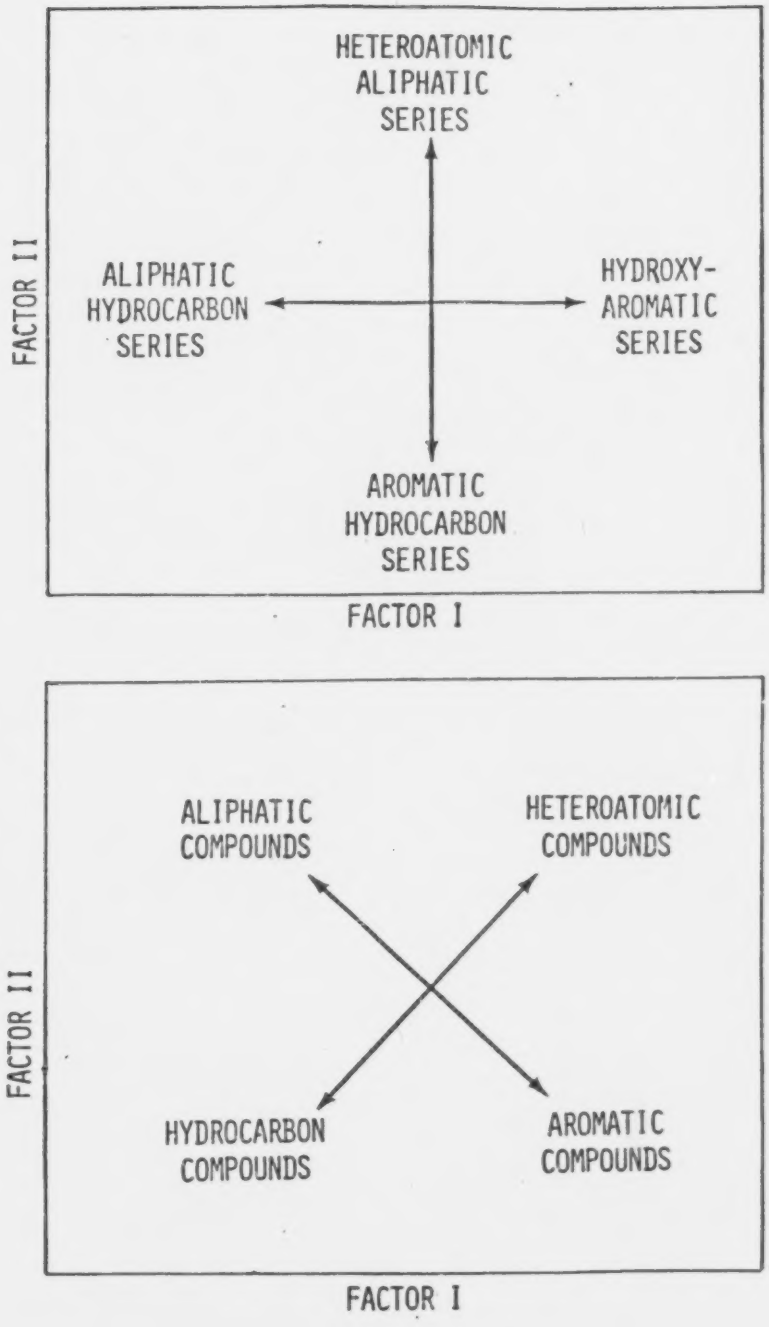

Figure 3. a, Main series of compounds represented by factors 1 and 11 in Figure 2; b, generalized interpretation showing underlying chemical tendencies obtained by a 45° rotation of (a).

Statement of

Joseph A. McElwain, Chairman of the Board

MHD Development Corporation

Butte, Montana

to the

Subcommittee on Energy Research and Development

Committee on Energy and Natural Resources

United States Senate

May 16, 1985

My name is Joseph A. McElwain. I am Chairman of the Board of the MHD (Magnetohydrodynamics) Development Corporation. In January, I retired as Chairman and Chief Executive Officer of the Montana Power Company. One of the primary purposes of the MHD Development Corporation is to initiate, promote and coordinate efforts toward effecting commercialization of the technology of Magnetohydrodynamics. The charter companies committed to this corporation are Avco Everett Research Laboratory, Inc., Babcock and Wilcox Inc., General Dynamics Corp., Gilbert/Commonwealth, Montana Energy Research and Development Institute, The Montana Power Company, MSE Inc., TRW Inc., and Westinghouse Electric Company. These companies and I have confidence in MHD.

The first action of the MHD Development Corporation was to propose an MHD retrofit demonstration project that provides for a fully integrated MHD development plant. The Montana Power Company will make its Frank Bird Power Plant available to the corporation as the retrofit host. The companies cited above participated in the proposal which offers to cost share 50 percent of the project on a 50/50 basis with the Government. It was submitted to the Deparment of Energy in response to the Program Announcement: Information Regarding Emerging Clean Coal Technologies, Federal Register, Volume 9, No. 229, 27 November 1984. The proposal entitled "Design, Construction and Operation of a Demonstration Coal-Fired Magnetohydrodynamic Steam Power Plant" also contains letters from the Electric Power Research Institute, Edison Electric Institute, MHD Task Force, and five representative utilities supporting the continued development of the MHD technology and this proposed demonstration project.

Formation of the MHD Development Corporation and the offer to cost share the project are tangible proof of industry interest, commitment and belief in the potential of the Magnetohydrodynamic technology. These charter companies are proposing a large stake in the project and are committed to its successful completion.

This corporation and its proposed project would not have come to fruition if the MHD technology development had not been able to meet its milestones or if the DOE had not developed its multiyear, proof-of-concept program directed toward an MHD retrofit. You can understand our discouragement, disappointment and frustration when the DOE proposed terminating the MHD effort in FY 1986.

DOE's multiyear program directed towards an MHD retrofit demonstration plant, which DOE presented to Congress in June, 1984, is a good program and an essential program if MHD is to come to fruition. The ramifications of dropping this program will affect many areas beyond MHD power generation. The nation's energy independence program, its credibility in high technology development and the Government's credibility as a partner in any cost-sharing venture are all at stake. Industry is serious about MHD, but it must have a partner, a reliable partner: the Government.

The DOE's June plan recognized that MHD is not a mature technology. MHD has high cost and a long lead-time to ultimate development. DOE's offer to make the CDIF and CFFF available to industry for further development is mute and unrealistic. Industry does not have the resources to assume responsibility for the proof-of-concept program. If the MHD development is to progress, the Federal Government must continue to underwrite the proof-of-concept with about the same level of private participation that already exists.

Substantial industrial investment will not begin until the retrofit stage. The near term financial conditions of the utilities and supporting industries does not permit substantial cost participation prior to the demonstration facility. As with all new and old technologies, substantial risk will still be present in the scale-ups required and in the first integration of all the MHD components into a working system in the demonstration plant. Any return on investment is a long-term situation, even after the demonstration project for marketing itself is lengthy and expensive. For MHD to be marketable, the durability and reliability tests must be successfully completed. Still, the large potential benefits indicate the risks are worthwhile.

The DOE plan says that "the MHD program has reached a critical decision point; the technology is ready for integrated proof-of-concept system/subsystem tests. It is time to focus the program on the least-cost, shortest development path to establish the technology base for MHD power systems." Upon successful completion of this program, the DOE plan calls for a "preliminary design (Title I) of the retrofit in late 1987 and the detailed design (Title II) in late FY 1987 or 1988." The MHD Development Corporation strongly supports this position and has designed its proposed MHD retrofit project to correspond to the DOE plan and to serve as the focus for the DOE's proof-of-concept program.

The proposed MHD retrofit at the Bird Plant would bring all the components and subsystems in a fully integrated facility for the first time and at a utility site. The size would be sufficient to address the technical phenomena that occurs with scale up, as well as large enough to address the risks involved in the additional scale up required for a commercial plant. It also will provide economic data and "hands on" utility operator experience. Transition to commercial demonstration would commence about 5.5 years after beginning of the preliminary design.

These project milestone dates can only be met if DOE's core program to test the components and prototypic hardware is maintained and taken to completion. The work initiated in previous years and being carried on at both the CDIF and CFFF in regards to coal combustion, channels, HRSR and downstream development, needs to be completed at the same time as the initial design stages of the demonstration project. Both aspects of this program, the DOE core proof-of-concept program and the demonstration project are timely and necessary to take the MHD technology to a useful completion.

As requested by the referenced PON, substantial (50 percent) sector cost participation is proposed. The industrial participation is backed by companies having the capability, experience, and resources to support this commitment. They have documented with letters of intent their willingness to participate with the Federal Government in this worthwhile project. Yet, participation with the Government as a partner does have its problems. These problems should be recognized both from the industrial and Government viewpoints. For example:

1. Current market conditions.

2. Market penetration costs and risks.

3. Patent positions.

4. Tenuous Government funding by Congress and/or the Administration.

5. Need for assurances of continuity.

It is encumbent on the Federal Government to prove itself as a reliable partner. A multiyear program directed towards the retrofit is essential. A return to the five year plan proposed by the DOE in their 1985 budget presentations is needed. A five year program alone, without adequate funding, would not achieve the goals required. Adequate funding would be approximately $40 million a year accompanied by a firm and reliable Government policy to pursue the proof-of-concept program to fruition. The start-stop policies of the past have minimized the effectiveness of the monies spent. The history of MHD does not give anyone confidence in the Federal Government as a reliable partner in developing energy systems.

Industry has contributed over $40 million to the development of MHD and can be expected to continue to contribute during the proof-of-concept program. The amount that will be contributed will depend upon Industry's perception of how serious the Government, and particularly the Administration, is regarding the continuation of the MHD program.

Since 1973 when the United States received the signal of our vulnerability to dependence upon foreign sources of energy, the need for internalizing our energy capability through the greater utilization of our vast coal resources has been recognized. As you are well aware, we have substantial political and socio-economic problems to overcome before nuclear power becomes

a continuing source of supply for our increased electrical energy needs. This leaves our great coal reserve as the one reliable source of internally generated energy. The United States possesses over 35 percent of the known coal reserves of the world, some 450 billion tons. The states of Montana, Wyoming and North Dakota possess approximately 45 percent of the U.S. coal reserve.

It is clear that coal must assume an increasing part of our national fuel mix. We all know how the coal window has enlarged versus the previously perceived nuclear option. But we have not been moving with dispatch in this critical area. In 1974, only 44 percent of the electricity produced by utilities came from coal. In 1980, that figure had grown by only 6 percentage points -- to only 50 percent -- while the consumption of electricity had leaped 19 percent.

Looking just a few years into the future, the best forecasts indicate that the demand for electricity will escalate 114 percent by the turn of the century because electricity is that blessedly versatile form of energy that can serve many needs. Coal could and should be used to generate more than 2/3 of our total electricity, assuming attractive economics and superior technology.

Yet, without MHD or some unforeseen exotic technology, coal cannot be expected to assume its destiny in our energy mix. Only with the massive gains in efficiency, economics and environmental control offered by MHD can coal play its assigned part in the shift from primary reliance on shrinking oil suppliers to our relatively abundant coal reserve. Prolonging the life of our coal supply through the efficiencies of MHD suggests that we should follow a course that will bring about expeditious application of this promising technology.

From the perspective of coal utilization, MHD presents the only direct coal conversion technology on the scene today that increases efficiency as well as meets environmental standards and goals. MHD can utilize all coals, both low and high sulfur.

MHD is a relatively simple conversion process which moves a hot conductive gas through a strong magnetic field which then causes current to flow in the gas. MHD has the highest potential efficiency of all the new coal-burning technologies; its combustion process inherently controls SO_x and NO_x. The impacts of burning coal 50 percent more efficiently has tremendous benefits in addition to fuel savings by reducing related environmental impacts through less mining, less transportation and less effluents.

From the perspective of the national need for electricity, a shift to electricity has evolved over many decades, as unique applications have been developed capitalizing on electricity's special end-use flexibility. Over the past 20 years, the total electricity made available for use in the United States has increased by more than 150 percent. The use of electric power continues to parallel the U.S. Gross National Product (GNP). Over the past 10 years non-electric energy use has declined by 16 percent while electric

power consumption has grown by a total of 25 percent. During this time span, the economy expanded by 25 percent. An increased use of electrical power has occurred in every sector of the economy -- residential, commercial and industrial. Again from 1973 to 1983, residential and commercial demand increased by 26 percent and 35 percent, respectively. Industrial use has rebounded from the 1982 decline, increasing 4.2 percent in 1983 and by a total of 13 percent since 1973.

From the perspective of the state-of-the-art for MHD, its track record in meeting its milestones is well known. Some of the advances warrant repeating from my testimony before this committee last year.

"The dollars spent have brought significant advances in recent years in areas which at one time were considered show stoppers.

1) Channel life has gone from seconds to minutes to 1300 hours testing and an extrapolated life of 8000 hours.

2) A 4800° coal combustor has been successfully developed and tested by TRW at the 20 MW_t level and 80 percent slag rejection with testing of a 50 MW_t combustor under way.

3) High temperature air heaters have not been successful. The near term alternative is the use of oxygen enriched air at a 3 to 4 percent efficiency loss, while development continues.

4) Steam bottoming data is encouraging - Argonne National Labs and CFFF have successfully used soot blowers to strip MHD-type ash from tubes and run successful coal-fired tests.

5) A super conducting magnet of 6.2 Tesla has been built and tested at Argonne National Labs.

6) A successful DC-AC inverter was developed by the Electric Power Research Institute and installed/operated at the CDIF.

7) Environmental Intrusion - CFFF tests on SO_x and NO_x are well below EPA limits.

8) Spinoffs have occurred - atmospheric slag rejecting coal combustors - low NO_x combustors - high temperature heat exchangers - hot gas (plasma) research, etc."

In summary, I urge adequate financial support of MHD as a technology whose long-term promise transcends parochial interests and the immediate Federal commitment to a broad range of budgetary stringencies. MHD offers our nation, its utility customers and its utilities exceptional opportunities to replace dwindling oil reserves with coal in our total energy mix; to conserve our lone abundant energy resource by making the most efficient possible use of coal; to burn coal in the most environmentally acceptable, efficient manner; to facilitate the ability of utilities to meet national energy goals; and to offer the user of electricity hope of genuine progress being made in combating the escalation of the price of that energy form. I believe continued support for MHD is imperative in the context of national interest. In conclusion, let me repeat: MHD has been funded for the past several years at $30 million, the absolute minimum needed to make meaningful progress. To achieve adequate progress in the proof-of-concept phase, $40 million is required annually. Thank you for your attention and consideration.

State of Illinois

For the Record

Chairman Domenici and members of the subcommittee, I am James R. Thompson, Governor of the State of Illinois. I welcome the opportunity to provide testimony in support of the establishment of the Clean Coal Technology Reserve created last year by the enactment of P.L. 98-473.

I share Congress' interest, expressed by the passage of the law, in assuring that the United States utilize its vast coal resources in an environmentally acceptable and economically efficient manner. To that end, the Act earmarked $750 million of Synthetic Fuels Corporation funding for a special fund - The Clean Coal Technology Reserve - to be administered by the USDOE. In addition to earmarking the money, Congress also directed USDOE to solicit statements of interest and project proposals designed to demonstrate emerging clean coal technologies.

The response to DOE's solicitation was strong. Over 175 proposals were submitted by utilities, industries, technology developers, and other interested groups throughout the nation. However, DOE's summary report, issued early this month, makes it clear that the agency does not intend to pursue a clean coal technology program. I urge this subcommittee to provide guidance in assuring that at least a portion of the earmarked funds are used for the purpose intended. I ask that you do so on behalf of citizens in scores of Illinois communities who depend on our coal industry for employment and for a stable and economical source of energy.

Most midwestern coal lies in the Illinois Basin, a vast reserve which the State of Illinois shares with Kentucky and Indiana. The Illinois Basin contains enough coal to supply electric power to the entire nation for well over 100 years. In Illinois alone, 181 billion tons of coal have been identified. Illinois' mineable reserves account for over ten percent of the nation's demonstrated reserve base.

Coal has played an important role in Illinois history. It fostered the development of the railroads and the rise of metropolitan living. It stimulated the growth of our state's industrial base. Coal has wielded enormous influence on the economic health of our state. In some of our communities, coal is the overriding economic force.

Last year, Illinois miners produced over 60 million tons of coal, amounting to about $1.8 billion in coal sales. This coal was used in Illinois and in 16 other states. As an industry, mining ranks 10th, just behind agriculture, in its contribution to our gross state product. But the economics of coal go far beyond the absolute numbers of dollars in sales. Every dollar spent on Illinois coal creates and maintains jobs. And every dollar spent on coal buys us more energy--more electric power, more process steam--than a dollar spent on other fuels.

Throughout the Midwest, where the economy is founded on energy-intensive, basic industries such as machinery, chemicals, steel, and agricultural processing, keeping energy costs low is vitally important. The future vitality of the midwestern industries and the potential of our states to attract new industries will depend, in part, on the availability of a secure and affordable source of energy such as Illinois coal.

However, even though our coal is a readily available and secure source of energy, has a high energy content and a relatively low production cost, and is found in close proximity to the nation's major transportation networks and industrial regions, its use has actually declined slightly during the past 15 years.

It's no secret to this subcommittee that it is the environmental issues surrounding the use of Illinois coal which have constrained its use in the past and threaten its viability in the future. Less than 0.2% of the coal found in the Illinois basin is "compliance" coal, capable of meeting sulfur dioxide emissions standards without desulfurization. While current and proposed environmental regulations are based on an incomplete understanding of the scientific factors involved, and while the geopolitics of energy resources act to force the regulatory process toward more stringent environmental controls, it is clear that there is public support for the broad goals of clean air and water, the preservation of our nations's lands and protection of the health of our citizens. In Illinois, we share these goals, and we have believed for some time that we must not only address the environmental issues of the last decade, but we must also be ready to cope with increasing constraints which could be placed on our coal industry in the future.

Both industry and government studies agree that Illinois will be one of the hardest hit coal producing states in the nation should strict acid rain control legislation be passed. Economic modeling studies by the Illinois Department of Energy and Natural Resources, the Congressional Research Service of the Library of Congress and others indicate that up to 30,000 jobs in mining and related industries could be lost in Illinois alone. Ripple effects on other sectors of the economy would compound the economic and social costs and reduce the availability of tax dollars to deal with the problem.

Illinois is acutely aware of the nature of the treat to the high-sulfur coal industry and to the economy of midwestern states. I have, therefore, made a long-term commitment to accelerate the development of technologies which would allow Illinois Basin coal to be used cleanly and economically. Failure to develop and pursue a comprehensive coal development program would amount to allowing our wealth of coal to go to waste. In Illinois, we have taken an aggressive posture. We are carrying out a development program that is geared to the issues of the '80s and beyond.

We mean for Illinois coal to be a contender in the energy marketplace. We are telling Illinois energy consumers that coal is an affordable, available fuel, and we are spreading the message to other states and nations. We are providing that there are technologies available which allow the use of coal within environmental standards. We are pushing the development of new technologies, and discovering more about the coal resources we have. And we are streamlining the regulatory process in Illinois so we can more expeditiously meet new demands for our fuel.

ILLINOIS COAL PROGRAMS

In the last five years, Illinois state government has committed some $62 million to solving the environmental issues and related factors which limit markets for our coal. State government has chosen its areas of involvement carefully. We have focused on actions which will complement, not compete or interfere with, ongoing technology development efforts in the private sector. In fact, most of our efforts have been in cooperation with the private sector.

COAL RESEARCH

Our first area of involvement is coal research. Any efforts to increase markets for our coal must recognize the fact that coal is a complex substance and that its chemical and physical makeup and behavior is not fully understood. During the last four years, I have dedicated nearly $6 million in state funds to research directed at unlocking the chemical complexities of coal and at the development of economical and effective techniques to remove sulfur and other impurities from coal prior to the combustion process. The involvement of the State has stimulated coal research at our fine Illinois universities and private laboratories and has brought together many scientists from diverse fields working in a coordinated effort through our Center for Research on Sulfur in Coal.

TAX CREDITS

Effective January, 1985, the State of Illinois is providing tax incentives to industry to invest in coal research and equipment to burn Illinois coal. This allows companies to take a credit against their Illinois corporate income tax of twenty percent of the amount donated to the Illinois Center for Research on Sulfur in Coal. Furthermore, the new law provides a tax credit of five percent of the cost of direct combustion or pollution control equipment purchased in order to maintain or increase the use of Illinois coal at an Illinois facility.

DEMONSTRATION PROGRAMS

The third element of state coal programs, and the largest, centers on Technology Development and Demonstration. We know that technologies are now emerging which can allow our coal to be used cleanly and efficiently. Industries and utilities have much to gain from using coal as a primary fuel, and their interest is high. But new coal technologies are expensive and capital intensive, and they involve an element of technical risk. In Illinois, we have found that government can provide the incentive needed for industry to take the lead in technology development, and to get new processes into the commercial arena. To date, the State of Illinois has provided some $56 million in partial support for full-scale demonstrations of new ways to use high sulfur coal in utilities and industry. With co-sponsors in the private sector, the program now represents nearly $300 million worth of projects in our state. I believe that the federal government also has a stake in ensuring that Illinois Basin coal resources contribute to the security and economic prosperity of the nation.

TECHNOLOGY COMMERCIALIZATION

Our fourth area of involvement is in the commercialization of new coal technologies. As part of our efforts, we have implemented a coordinated program to expedite the permit process for major energy development projects. Futhermore, our commercialization efforts will expand this year with a new $55 million revolving loan program, which will provide low-interest state loans to industries for clean coal-use system. I believe that this program will speed the commercial use of the best new technologies which have emerged from research and development in Illinois and elsewhere, and will help us to realize the ultimate goal of our efforts.

WHAT IS THE APPROPRIATE FEDERAL ROLE IN FOSSIL FUEL RESEARCH AND DEVELOPMENT?

We in Illinois are justifiably proud of our efforts. But I am here to tell you, on behalf of the citizens of my state and the other states which depend of high sulfur coal for energy and economic viability, that we need the federal government's full participation in these endeavors. The fact that 175 proposals have been received by USDOE from utilities, industrial firms and the states is indicative of a strong, broad-based nationwide interest in the development of clean coal technologies. One of the Illinois proposals, submitted jointly with the Electric Power Research Institute, is for the demonstration of a low-cost retrofit technology which can reduce emissions of sulfur dioxide and nitrous oxides from utility power plants. I believe this kind of technology break-through is critical to the future of Illinois Basin coal markets, and it merits your attention and support.

Bill Vaughan, Assistant USDOE Secretary for Fossil Energy, has been quoted as saying "The days of government-funded technology development and demonstration are over." Illinois respectfully disagrees. Now more than ever, the federal government should be participating fully in a national effort to stimulate the development of clean coal technologies for commercial applications. Yet USDOE's budget for fossil energy research and development has been cut by more then $100 million for FY 86. As it becomes more and more likely that Congress will act to address the perceived acid rain problem, the development of clean coal technologies may be the least costly and most effective control method for compliance with Clean Air Act emissions requirements. Government should not inhibit the development of new technology on the one hand, while threatening more stringent regulation on the other.

Furthermore, current estimates of electrical capacity demands suggest that a shortfall may be likely during the 1990's. The utility industry is not in a position to experiment with different means of meeting the increased demand. Regulated utilities cannot now incorporate the expense of commercialization of clean coal technologies in the rate base. If the technologies are to be embraced by the utilities and industries, they need to be developed to the full commercial stage. This requires a joint partnership between public utilities, private industry and government - both federal and state. Illinois, for one, is doing its part. It is up to the federal government to bear its share in seeing that our country is able to utilize its coal resources in environmentally acceptable manner.

Thank you.

TESTIMONY OF

SOUTHWESTERN PUBLIC SERVICE COMPANY

BEFORE THE

UNITED STATES SENATE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

ENERGY RESEARCH AND DEVELOPMENT

SUBCOMMITTEE

MAY 16, 1985

Comments should be addressed to:

W. R. Esler, Executive Vice President
Southwestern Public Service Company
P.O. Box 1261
Amarillo, TX 79170

Southwestern Public Service Company (SPS) is grateful for the opportunity to present testimony on the emerging Clean Coal Technology issue.

SPS is an investor owned electric utility providing for the electrical needs of a population of more than one million people. SPS serves eastern New Mexico, the Panhandle and South Plains of Texas, the Panhandle of Oklahoma and southwestern Kansas.

SPS provides for the generation, transmission and distribution of electrical energy by means of an integrated interstate generation and transmission system that is augmented by interconnections with the Southwest Power Pool on our eastern side, and by direct current interties to the Western Power Grid at Clovis and Artesia, New Mexico. The Company has in place over 3,700 megawatts (MW) of generating capacity, 1,664 MW of which is coal-fueled. The Company will also add, in the early summer of 1985, 561 MW of coal generation at Tolk Station, near Muleshoe, Texas.

SPS is proud that this generating capability will be placed in service at a comparatively low cost to our customers. This 1985 unit has been constructed for about $549 per kilowatt. This is because SPS is one of the very few electric utilities that design and supervise construction of their own power plants. SPS has done all of its own plant design, in-house, since the early 1950s. It has a total-service department of engineers and other professionals.

The Company is noted in the industry as a innovator. Among its accomplishments are:

A. SPS was the first utility in the nation to use municipal sewage effluent for plant cooling. SPS has "written the book" on the use and management of this once wasted resource. It currently

has 2,105,000 kw of generation cooled with this product, and an additional 1,144,000 kw of generation proposed for the 1990's that will be cooled with sewage effluent.

B. SPS was the first utility to apply electrically adjustable frequency (A/F) drivers to fan service on a new utility boiler, resulting in significant savings of station power and fuel. With the start-up of its Tolk Station Unit 1 in 1982, SPS began operation of 24,000 Hp of A/F equipment. The station operates with approximately 5% station power, one of the lowest station power consumptions for a coal-fired power plant in the nation.

C. SPS placed into service the world's first digital turbine-generator controller when Jones Station Unit 1 went into service in 1971. In 1980, SPS completed the installation of one of the first -- and still one of the few -- digitally based, boiler-coordinated control systems. It is at Harrington Station Unit 3, SPS's first totally computer-controlled facility. Similarly equipped are Tolk Station Units 1 and 2, on line in 1982 and 1985, respectively.

D. SPS was the first utility to apply the removal of particulates by fabric filters at a new utility-size boiler. This was accomplished with the start-up of Harrington Station Unit 2 in 1978. Since that pioneering effort, all of SPS' new units have been similarly equipped. Tolk Station Unit 2 when it goes on

line in 1985 will be equipped with a reverse-air fabric filter designed totally in-house.

E. The EPA's existing standard for particulate emissions for coal-fired power plants is based on data provided by SPS. This was accomplished when, under contract to the EPA, SPS characterized the emissions for the Harrington Station Unit 2 fabric filter. Other joint EPA-SPS particulate collection work has been performed over the past five years in a small, two-compartment, side-stream fabric filter adjacent to the Harrington Station Unit 2 fabric filter.

F. SPS is designing in-house and fabricating its own mechanical draft cooling towers. The cooling tower to be placed in service with the commissioning of Tolk Station Unit 2 will be the second tower so designed and fabricated.

G. In 1982 SPS installed the first continuous bottom-ash removal system to be placed in service on a utility boiler in the United States. It was installed at Tolk Station Unit 1. A similar unit is being installed on Tolk Station Unit 2, and similar units are being retrofitted on SPS' three units at Harrington Station. The systems help conserve one of our area's more scarce resources -- water.

H. SPS has been able to market all of the ash products from the Wyoming coal burned at its Harrington and Tolk Stations. The

ash is used in structural concrete, oil-well concrete, as a road-base material to "top out" asphalt highways, and as a road de-icer. Some of the Tolk Station flyash is shipped by rail as far west as California. The successful marketing of this otherwise burdensome product is the best possible solution to its disposal from power plants.

Because of projected growth within the service area, we will have a need for another 550 MW of generating capacity to be on line around 1990. SPS in 1983 and 1984 placed orders for a turbine generator, boiler and other major equipment for this unit to be constructed northeast of Lubbock, Texas.

The unit will be coal-fueled. The most likely source of the coal is the Trinidad-Raton coal basin of New Mexico. This quality coal has a high Btu content(12,000/lb) and is low-sulfur (.6%).

Because SPS management has a keen interest in providing electrical power to our customers at the lowest possible cost and in protecting the environment of the area we serve, the Company in 1984 began considering the environmental requirements the 1990 generating station must meet.

Perhaps the most significant new environmental requirement that this power plant must meet is contained in 42 USC § 7411 of the Clean Air Act, that section more commonly referred to as the "Percentage Reduction Requirement."

This statute and the regulations (40 CFR § 60.43a) promulgated by the Environmental Protection Agency (EPA) to carry out the law have presented SPS with a paradoxical challenge, that challenge being, to achieve a 70% reduction in the possible sulfur that could be emitted in the exhaust gases of the boiler, to conserve the scarce ground water in

the underlying Ogallala Aquifer, and lastly but equally important, to achieve the above at the least-possible cost to our customers.

Our search for ways to meet these goals indicated spray-dry scrubbing may be the best available technology for meeting the 70% sulfur reduction requirement.

This method of sulfur dioxide (SO_2) removal on a 550 MW unit would require consumption of enough water to supply a community of about 5,000 people. The cost for removal by spray-dry scrubbing of SO_2 is about $1,500 per ton.

It was concluded, in the late summer of 1984, that in spite of company management misgivings about the cost effectiveness of spray-dry scrubbing and the other non-air environmental impacts of this method no other demonstrated sulfur removal technology is available.

However, meetings with Congressional staff members and various individuals with the EPA, and the Department of Energy to discuss management's apprehensions, uncovered a strong desire to promote new technologies for meeting SO_2 reduction standards.

Perhaps one of the most advanced emerging technologies ready for commercial, cost-effective demonstration is the Limestone Injection Multistage Burner method (L.I.M.B.). L.I.M.B. involves the injection of limestone or hydrated lime into the furnace, thereby causing a reaction to occur that allows SO_2 to bind with lime solids to form a dry residue.

E.P.A's Office of Research and Development has found that L.I.M.B. can remove significant percentages of SO_2 in a small pilot boiler. The Office of Research and Development is coordinating the retrofit of an existing utility boiler in Ohio with L.I.M.B. to ascertain the effectiveness of the techonology on Eastern United States high sulfur coals.

Opportunities however, are limited for demonstration of L.I.M.B. techonology on a new utility boiler, particularly one burning Western low-sulfur coal.

The order by SPS for a boiler for its 1990 unit is the first domestic order for a large utility boiler since 1982. The E.P.A. proposed that SPS construct this new boiler using L.I.M.B. as the primary SO_2 removal method.

Because of E.P.A.'s enthusiasm in promoting this innovative technology and in the interest of meeting SPS's goals of water conservation and economical SO_2 removal, on November 21, 1984, company management offered E.P.A. the commercial demonstration of L.I.M.B. on its 1990 unit at no capital costs to the federal government. (APPENDIX I)

In return for advancing the state of the art of L.I.M.B., SPS requested a Commercial Demonstration Waiver (40 CFR, Part 60 Subpart Da, Section 60.45a) and a unique New Source Performance Standard consistent with predictable maximum sulfur removal via L.I.M.B. using reasonable limestone reagent amounts.

SPS reasoning leading to the request for a unique standard was the uncertainty of meeting a 70% sulfur reduction with an emerging technology. The same type of uncertainty was also broadly expressed by E.P.A. before the standard was promulgated (testimony of the Assistant Administrator for Air and Waste Management, E.P.A., before the Subcommittee of Fossil and Nuclear Energy Research, Development and Demonstration, Committee on Science and Technology, U.S. House of Representatives April 26, 1978). SPS also felt that should L.I.M.B. fail to perform at a 70% reduction, retrofit of a spray-dry scrubber might be required --- at a significant additional cost.

E.P.A. responded with a proposed change in the Commercial Demonstration Waiver and a probable 10-year-waiver period after which the unit would be required to meet the 70% reduction.

The reluctance on the part of SPS to risk our customer's money on a gamble that may not be successful, combined with E.P.A.'s reluctance to grant a permanent waiver from the 70% SO_2 reduction requirement on a boiler not totally engineered for L.I.M.B., have combined perhaps, to make this innovative project economically unattractive.

Other technologies that show promise for economically removing sulfur from utility boiler emissions include the post-furnace injection of sodium-based reagent into the flue gases. SPS, in conjunction with the E.P.A. may demonstrate this method on a small, pilot baghouse installed at one of our Amarillo, Texas, coal-fueled units.

It is understood Fluidized Bed Furnaces also show promise for the future, but demonstrations will be slow to materialize on large units because of the inability to retrofit existing technology should Fluidized Bed Furnaces demonstrations fail. (APPENDIX II)

In conclusion, Southwestern Public Service Company believes some new Clean Coal Technologies are ready to be commercially demonstrated.

SPS, as our offer indicates, was and still is willing to demonstrate new technologies at no significant cost to the government provided that the E.P.A. is willing to allow standards for those units that are consistent with the results of the experiments. Company management feels that the E.P.A. has been granted this authority by Congress and that no legislative changes are required to accomplish this.

SPS is also of the opinion that should the regulatory risks be eliminated for the demonstrations of these new cost effective emerging

technologies, other entities would be willing to try them also at no significant cost to the federal government.

Congress, by requiring a review of standards of performance every four years (Clean Air Act - Section III(b)(I)(B)), apparently intended that E.P.A. fine tune its regulations to accommodate new technological developments.

Perhaps this type of review would show the deficiencies in current regulations as applied to new technologies, and allow for economical demonstrations of SO_2 removal technologies that promote sensitivity to economy and to non-air environmental impacts.

W. R. Esler
Executive Vice President
Southwestern Public Service Company

APPENDIX I

SOUTHWESTERN PUBLIC SERVICE COMPANY
P. O. BOX 1261 • AMARILLO, TEXAS 79170 • 806/378-2121

W. R. ESLER
EXECUTIVE
VICE PRESIDENT

November 21, 1984

The Honorable William D. Ruckelshaus
Administrator
United States Environmental Protection Agency
401 M. Street SW
Washington, D.C. 20460

Dear Mr. Ruckelshaus:

I am writing to propose a project for which absolutely no government funding will be required, while bringing to commercialization an innovative environmental control technology. Limestone Injection Multiple Burners (LIMB) hold considerable promise as sulphur-removing equipment in electric-utility-size boilers.

Southwestern Public Service Company proposes to design and build "from the ground up" a LIMB system for its South Plains Station, currently planned as two 572,000 KW electric generating units. The first of these units will go on the line in 1990. All LIMB equipment and engineering will be furnished by Southwestern.

In return for advancing the state-of-the-art of LIMB and for working with EPA to demonstrate the merits of this technology, Southwestern requests that our station be given a Commercial Demonstration Waiver in order to operate under a standard adopted uniquely for our specific site (40CFR, Part 60, Subpart Da, Section 60.45a). This standard would be established as a result of a best-faith effort to achieve maximum sulphur removal via LIMB with reasonable reagent usage.

Southwestern offers a unique opportunity for advancing the state-of-the-art in LIMB technology. Attached are the major reasons for the viability of our project.

We have met with and reviewed much of this information with Frank Princiotta, Director of the Industrial Environmental Research Laboratory in Research Triangle Park and persons in the office of Jack Campbell, Deputy Assistant Administrator of Policy, Office of Policy, Planning and Evaluation, in Washington. All of the EPA personnel with whom we have discussed this project have encouraged us to believe the technology has merit, and have prevailed upon us to seek this waiver.

We look forward to your early positive response to this proposal.

Yours truly,

W. R. Esler

WRE:gb

Attachments

FACTS ABOUT
SOUTHWESTERN PUBLIC SERVICE COMPANY

1. Southwestern Public Service Company (SPS) is an investor-owned electric utility with headquarters in Amarillo, Texas. SPS primarily provides electric service for a population of more than one million in a 52,000-square-mile area comprising the Panhandle and South Plains of Texas, eastern and southeastern New Mexico, the Oklahoma Panhandle and southwestern Kansas.

2. SPS is one of the very few electric utilities that design and supervise construction of their own power plants. SPS has done all of its own plant design in-house since the early 1950s. It has a total-service department of engineers and other professionals.

3. SPS is noted in the industry as an innovator. Among its accomplishments are:

   A. SPS was the first utility in the nation to use municipal sewage effluent for plant cooling. SPS has "written the book" on the use and management of this once wasted resource. It currently has 2,105,000 kw of generation cooled with this product, and an additional 1,144,000 kw of generation proposed for the 1990s that will be cooled with sewage effluent.

   B. SPS was the first utility to apply electrically adjustable frequency (A/F) drivers to fan service on a new utility boiler, resulting in significant savings of station power and fuel. With the start-up of its Roy Tolk Station Unit 1 in 1982, SPS began operation of 24,000 Hp of A/F equipment. The station operates with approximately 5% station power, one of the lowest station power consumptions for a coal-fired power plant in the nation.

   C. SPS placed into service the world's first digital turbine-generator controller when Jones Station Unit 1 went into service in 1971. In 1980, SPS completed the installation of one of the first -- and still one of the few -- digitally based, boiler-coordinated control systems. It is at Harrington Station Unit 3, SPS' first totally computer-controlled facility. Similarly equipped are Tolk Station Units 1 and 2, on line in 1982 and 1985, respectively.

   D. SPS was the first utility to apply the removal of particulates by fabric filters at a new utility-size boiler. This was accomplished with the start-up of Harrington Station Unit 2 in 1978. Since that pioneering effort, all of SPS' new units have been similarly equipped. Roy Tolk Station Unit 2 will be equipped with a reverse-air fabric filter totally designed in-house, when it goes on line in 1985.

E. The EPA's existing standard for particulate emissions for coal-fired power plants is based on data provided by SPS. This was accomplished when, under contract to the EPA, SPS characterized the emissions for the Harrington Station Unit 2 fabric filter. Other joint EPA-SPS particulate collection work has been performed over the last five years in a small, two-compartment, side-stream fabric filter adjacent to the Harrington Station Unit 2 fabric filter.

F. SPS is designing and fabricating its own mechanical draft cooling towers in-house. The cooling tower to be placed in service with the commissioning of Roy Tolk Station Unit 2 will be the second tower so designed and fabricated.

G. In 1982 SPS installed the first continuous bottom-ash removal system to be placed in service on a utility boiler in the United States. It was installed at Roy Tolk Station Unit 1. It is being installed on Roy Tolk Station Unit 2 and is being retrofitted on SPS' three units at Harrington Station. The system helps conserve the most precious of our area's resources -- water.

H. SPS has been able to market all of the asn products from the Wyoming coal burned at its Harrington and Tolk Stations. Some of the Tolk Station flyash is shipped by rail car as far west as California. The successful marketing of this otherwise burdensome product is the best possible solution to its disposal from power plants.

I. SPS brings a unique blend of resources to the timely consummation of LIMB research:

* SPS' in-house engineering capability lends itself to the timely implementation of concepts and solutions.

* South Plains Station will provide the setting for the implementation, from the beginning, of a LIMB design for a tangentally fired boiler -- not a retrofit.

* The uniqueness of the SPS service territory and the receptiveness of the people we serve give the best possible forum for consideration of issues such as improved water conservation resulting from the site waiver sought for South Plains Station.

* SPS has a history of being innovative and of making things work. Publicly available information will support the fact that the past five coal-fired units built by SPS have been built for considerably below the then-current "national average" cost. A tour of these facilities will convince even a skeptic that these savings have been achieved wihout a compromise in quality.

4. In summary, SPS can offer an unusually appropriate set of circumstances for commercialization, at no cost to the government, of an important technology that demands full-scale, user-verified legitimacy. Current regulations do not provide appropriate incentives for innovations. In fact, they have the net effect of stifling innovation. SPS asks for the opportunity to advance LIMB technology.

SOUTHWESTERN PUBLIC SERVICE COMPANY
P. O. BOX 1261 • AMARILLO, TEXAS 79170 • 806/378-2121

J. B. MATTHEWS
VICE PRESIDENT
GENERATION PLANT DESIGN
AND CONSTRUCTION

February 12, 1985

Mr. Jack S. Siegel
Deputy Director for Coal Utilization
Advanced Conversion and Gasification
Fossil Energy
U.S. Department of Energy
FE-20, GTN
Washington, D.C. 20545

Dear Mr. Siegel:

Southwestern Public Service Company is pleased to submit this proposal in response to the Department of Energy's solicitation of "Statements of Interest and Informational Proposals." This proposal represents an effort by SPS Company to meet the intent of the Federal Clean Air Act while reducing the cost to the electric consumer and reducing the consumption of other natural resources.

SPS Company recognizes that DOE has no resources to fund this project. The primary purpose of this response is to identify the Federal incentives to accelerate the commercial availability of the LIMB technology. To encourage the development of LIMB as a viable SO_2 control technology for new coal-burning plants, DOE should recommend in its April 15, 1985 report to Congress a modification in the sulfur dioxide percentage reduction requirements for a commercial demonstration plant to be built in Lubbock County, Texas.

SPS is a leader in the application of innovative technologies for power generation. Our reputation for designing and constructing highly reliable new power generation facilities at costs well below the national average is known throughout the electric utility industry. We will apply the same high degree of diligence and attention to this project which we presently apply to all phases of our company operations.

Very truly yours,

J. B. Matthews

J. B. Matthews
Vice President
Generation Plant Design and
Construction

JBM:kh

CLEAN COAL TECHNOLOGY

This Submission is provided in response to the DOE Program Announcement for Information Regarding Emerging Clean Coal Technologies.

1. Southwestern Public Service is an investor-owned electric utility with headquarters in Amarillo, Texas. SPS supplies electricity to over 330,000 customers in an area of 52,000 square miles, including the Panhandle and South Plains of Texas, eastern New Mexico, the Panhandle of Oklahoma and southwestern Kansas. The Company has nine steam electric generating stations with a total generating capacity of 3,604,000 kw.

Four units (with a total generating capacity of 1,664,000 kw) burn low sulfur sub-bituminous coal from the Powder River basin in Wyoming with another 543,000 kw unit scheduled to begin operation during the Spring of 1985.

Southwestern Public Service Company (SPS) is presently engineering two 572,000 kw coal-fueled steam electric generating units known as South Plains Station Units 1 and 2. The first of these units is presently scheduled to go on line in 1990. This plant is located in Lubbock County on the Texas High Plains. SPS proposes to design and build "from the ground up" a Limestone Injection Multistage Burner (LIMB) system for this power plant. All LIMB equipment and engineering will be furnished by SPS.

LIMB is a technology for injecting into the furnace a sorbent for capturing sulfur dioxide. A pulverized calcium-based material such as limestone or calcium hydroxide is injected directly into the furnace of a coal-fueled boiler. The sorbent rapidly calcines to form a porous microstructure with greater exposed surface area for reaction with sulfur dioxide. The resulting lime particles are highly reactive and chemically combine with SO_2 to form calcium sulfate and sulfite. This product is then collected, along with fly ash, in the baghouse.

One of the basic purposes of this proposal is to ultimately reduce emissions in such a manner that compliance with air quality regulations

will not inhibit economic growth. In the plains of West Texas, eastern New Mexico, and the Oklahoma Panhandle, air quality considerations are not as critical to economic growth as are water resource utilization. A major consideration of LIMB as a method of SO_2 control is that it is a dry technology and utilizes no water during the process. On the average, annual rainfall in this region totals twenty inches; however, some counties receive as little as eight inches. Therefore, most of the communities in this region are dependent upon the Ogallala Aquifer for potable water and for irrigation. It is an established fact that the Ogallala has little, if any, recharge.

Agriculture is a major industry of the area. The flat land is especially well suited to today's large scale mechanized farming. With adequate water, this land is highly productive. During the past three decades, the region has made a substantial contribution to the nation's food and fiber supplies.

A substantial portion of the U.S. agricultural market is represented by several corps. This region contributed over thirty percent of the nation's production of grain sorghum in 1971. More recently, twenty-five percent of the nation's grain sorghum was produced here, and the region averaged eighteen percent of the nation's output of cotton. Corn has also become a leading crop in this area. And due to the abundance of these feed grains, the region has perhaps the heaviest concentration of fed cattle in the nation.

Irrigated acreage has grown steadily from less than one-half million acres in 1944 to over five and one-half million acres. The potential in

this region would be practically unlimited if there were an adequate supply of water for irrigation. Some, formerly irrigated areas, have been returned to dryland farming, or lie idle because of limited groundwater supplies. After 1985, a steady reduction in groundwater supplies is expected to reduce irrigated acreage, resulting in an area-wide retrogression to dryland farming. The economic consequence, not only on a state level, but on a national scale, could be severe. In areas where water resources are as important as they are in SPS's service territory, methods of emission control which minimize water consumption are desperately needed.

2. This application of LIMB to South Plains Station would be the first such application to a new coal-fueled boiler in the United States. This project would allow LIMB to be incorporated into the original design and construction of a new tangentially-fired coal boiler. EPA presently has a contract with Ohio Edison to retrofit an existing B&W boiler which burns 3% sulfur eastern coal. Pennsylvania Electric also has a test plan for LIMB on its existing Homer City Plant, but it will be on a existing utility boiler burning eastern high sulfur coal. The boilers at South Plains Station will be equipped with additional soot blowers. A sorbent storage, preparation, and injection system will be added. The fabric filters and ash removal systems will be sized for the additional materials loading.

3. SPS would be the sole owner of the plant and the LIMB equipment.

4. The projected capital costs are $20,000,000 with operating and maintenance

costs ranging from $2,400,000 to $4,500,000 per year depending upon reagent selection. (1985 $'s) Testing costs will depend on the extent and duration of the project. Site preparation will begin in early 1986 for South Plains Station. Steel erection will begin in 1986, and plant completion will be in the Spring of 1990 with turbine roll to follow. After the plant is operational and declared commercial, LIMB testing may begin.

5. The coal proposed for this project is a low-sulfur western fuel from northeast New Mexico. See Table 1 for actual coal analysis.

6. Research by EPA's Industrial Environmental Research Laboratory (IERL) indicates that, with certain sorbents and relatively high stoichiometric ratios, an upper limit of 70% reduction is achievable in a one million Btu/hr test furnace. Boilers burning Austrian brown coal are achieving 50% reduction. Previous work in the United States revealed reductions of 15% to 30%. It is impossible to accurately predict the percentage reduction on this low sulfur coal in a utility-sized furnace. A demonstration plant is needed to fully develop the technology.

7. SPS proposes to fully finance the engineering and construction of the LIMB system for sulfur dioxide removal at South Plains Station with the usual investor-owned public utility financial methods through bonds, common and preferred stock. Existing environmental statutes and regulations do not provide adequate incentive for industry to demonstrate this technology because of the stringent standards required for percentage reduction. SPS proposes that DOE recommend to Congress, that for this demonstration

plant, the existing percentage reduction requirements be waived and that a site-specific standard be established as a result of a best-faith effort to achieve maximum sulfur removal via LIMB with reasonable reagent usage. Costs of testing and costs of reagents should be funded by DOE because the results of this test program will further the acceptance of LIMB as a viable means of flue gas desulfurization for utility boilers.

8. Project economics: (1985 $'s)

Capital Costs:	$20,000,000
O & M Costs:	1,250,000/yr.
Sorbent Costs:	500,000/yr. to 4,500,000/yr
Disposal Costs:	500,000/yr.
Power Costs:	500,000/yr.

Economics of the proposed project are based upon the coal analysis and plant size presented in the proposal and on a plant capacity factor of 70%. In order for this technology to be fully developed, it must compete economically with the conventional proven technologies of wet limestone scrubbing and spray drying. LIMB presents an excellent opportunity to reduce the capital requirements for flue gas desulfurization on new plants. The reagent costs for absorption of SO_2 can be prohibitively high if reasonable stoichiometric ratios and reagent costs are not used. This process has the potential of reducing the annual costs of sulfur dioxide control to the electric customer by fifty percent.

9. This project will generate electricity which will be transmitted by Southwestern's existing electrical grid.

Bottom ash and fly ash products from the process would be land-filled on site until it could be determined whether the ash products could be

used for road bed or pozzolanic materials.

SPS has been pursuing this concept of a demonstration plant with the headquarters of the EPA, the regional office of the EPA, and the Texas Air Control Board.

The management of SPS believes that the LIMB method for removing sulfur dioxide emissions from low sulfur coal-fueled power plants presents the opportunity of meeting reasonable percentage reduction requirements at lower capital and operational costs than do other available and "proven" technologies. LIMB also presents the opportunity to preserve the limited water resources of the Texas High Plains.

TABLE #1
SOUTH PLAINS STATION COAL ANALYSIS

AS-RECEIVED BASIS	TYPICAL
Total Moisture, %	4.00
Ash, %	15.00
Volatile Matter, %	36.00
Fixed Carbon, %	45.00
Total Sulfur, %	0.57
High Heating Value, Btu/lb.	12,000
Ultimate Analysis, %:	
C	66.86
H	4.83
N	1.44
Cl	0.01
S	0.57
Ash	15.00
O_2	7.29
Water Soluble Alkalies:	
Na_2O, %	0.034
K_2O, %	0.005
Hardgrove Grindability	52
DRY ASH BASIS	
Ash Composition, %	
SiO_2	50.83
Al_2O_3	25.24
TiO_2	1.05
Fe_2O_3	6.95
CaO	7.61
MgO	1.46
K_2O	0.97
Na_2O	0.59
SO_3	3.97
P_2O_5	0.42
Undetermined	0.91
Ash Fusion Temp., °F:	
Reducing - I.T.	2390
S.T. (H=W)	2450
H.T. (H=W/2)	2510
F.T.	2600
Oxidizing- I.T.	2490
S.T. (H=W)	2540
H.T. (H=W/2)	2580
F.T.	2650

APPENDIX II

SOUTHWESTERN PUBLIC SERVICE COMPANY
P. O. BOX 1261 • AMARILLO, TEXAS 79170 • 806/378-2121

J. B. MATTHEWS
VICE PRESIDENT
GENERATION PLANT DESIGN
AND CONSTRUCTION

February 13, 1985

Mr. Jack S. Siegel
Deputy Director of Coal Utilization
Advanced Conversion and Gasification
Fossil Energy
U.S. Department of Energy
FE-20, GTN
Washington, D.C. 20545

Dear Mr. Siegel:

In response to the Department of Energy's solicitation of "Statements of Interest and Informational Proposals," Southwestern Public Service Company is pleased to submit the following proposal for the retrofit of an Atmospheric Fluidized Bed Boiler at an existing operating plant. This proposal represents Southwestern Public Service Company's effort to meet the intent of the Federal Clean Air Act and, at the same time, reduce the cost of electric energy to the consumer and reduce the consumption of other natural resources.

Southwestern Public Service Company recognizes that the DOE has no resources to fund this project. The primary purpose of this response is to prove the worth of AFBC boilers in the reduction of NO_x and SO_2 emissions and to prove the viability of AFB boilers for the retrofitting of existing medium and large size utility stations.

Southwestern Public Service is a leader in the application of innovative technologies for power generation. Our reputation for designing and constructing highly reliable new power generation facilities at costs well below the national average is known throughout the electric utility industry. We will apply the same high degree of diligence and attention to this project which we presently apply to all phases of our company operations.

Very truly yours,

Albert A. Davis for

J. B. Matthews
Vice President
Generation Plant Design and
Construction

JBM:kh

ATMOSPHERIC FLUIDIZED BED COMBUSTION

1. Description of Process and Overall Project

Atmospheric Fluidized Bed Combustion (AFBC) is a process whereby coal and a sorbent (limestone) are combined in a fluidizing bed at relatively low operating temperatures. The temperatures are well below the thermal NOx formation point and the added sorbent absorbs the SO_2, which is released during combustion, eliminating the need for downstream scrubbers.

The project involves replacing a gas-fired boiler with an AFBC. The gas-fired boiler provides 1,742,000 pounds per hour of main steam at 1890 psig and 1000°F and 1,562,000 pounds per hour of reheat steam at 476 psig and 1000°F to a single reheat double flow turbine producing 234 MW at a net heat rate of 10,350 BTU/KWH. The unit began commercial operation in 1968.

The advantages of replacing the present gas-fired boiler with an atmospheric fluidized bed combustor are threefold.

1. It will allow the use of a low cost, relatively abundant fuel (coal) in place of a scarce, high cost fuel (natural gas).

2. Because of the high cost and scarcity of the present fuel, the unit is run as a cycling unit with a capacity factor of 0.29. With more abundant fuel, the unit would be run as a base load type unit with a capacity factor of 0.70, comparable to Southwestern's existing coal-fired units.

3. In order to meet existing, and pending, clean air requirements, some utilities with coal-burning units may be required to retrofit those units with expensive to build, expensive to operate scrubber systems. Not only are scrubber systems expensive to operate, the waste material can

present a problem to present water sources as the flue gas does to the atmosphere.

Replacing the existing boiler with an AFBC will negate the need for a scrubber. The need for disposal of waste has not been eliminated; however, the amount of waste is reduced and handling and storing of dry waste is considerably easier than wet scrubber sludge.

The construction and operation of the unit proposed would demonstrate the capability of the AFBC technology to reduce both NOx and SO_2 emissions without the attendent costly installation and operation of scrubbers.

2. Comparison to Similar Units

At the present time there are no medium or large scale utility atmospheric fluidized bed combustors in operation. Colorado Ute Electric Association has purchased a 900,000 pound per hour unit to supply steam to three small existing turbines and a new turbine. These four units will have an approximate gross output of 100 MW. The steam will be supplied at 1510 psig and 1005°F. The economizer inlet conditions are 440°F at 1635 psig. No reheat is provided. The unit will cycle depending on system load requirements.

The AFBC proposed would supply 1,742,000 pounds per hour of main steam at 1890 psig and 1000°F, and 1,362,000 pounds per hour of hot reheat steam at 476 psig and 1000°F. The economizer inlet conditions are 473°F at 2380 psig. The boiler output will drive a 234 MW single reheat double flow turbine.

3. Proposed Ownership

The owner of the project will be Southwestern Public Service Company.

4. Project Capital, Operating, and Testing Cost and Schedule for Construction and Testing of the Project Facility.

All cost figures are in 1985 dollars.

Estimated capital cost of the AFBC and all supporting structures is $101,684,071/year.

Since the boiler to be replaced is presently supplying an operating unit, only the differential cost between operating the present gas-fired unit and the proposed AFBC unit was calculated. The differential cost including additional maintenance, operating and chemical costs is $1,572,160/year.

Since this will be a base load operating unit, most of the data required for testing will be required for operations. Therefore, it will be difficult to separate the cost of testing from the cost of operation. However, personnel time required for testing will be in addition to operating time. Cost of additional instrumentation for testing will be approximately $250,000. The cost of additional personnel time will be approximately $450,000.

5. Analysis of Coal to be Used

See Attachment "A" for analysis. The coal to be used will be a Wyoming low sulfur coal that is presently being used in a station located approximately one mile from the proposed AFBC site. The coal will be transported to the proposed site by conveyors.

6. The Emissions Reduction to be Achieved by This Facility

It is expected that the emissions reduction for a retrofit application will be equal to or better than the NSPS requirements for a new site. The present NOx emissions limits are 0.5 pound per 10^6 BTU for new site installations. Since the operating temperature of an AFBC is well below

the thermal NOx formation point, it is expected that the NOx emissions can be reduced to the 0.2 to 0.25 pounds/10^6 BTU level.

The AFBC will be burning a low sulfur (0.3%) coal with an NSPS SO_2 removal requirement of 70 percent. It is expected that the SO_2 removal rate will be 70 percent plus. The construction and operation of a medium size reheat AFBC will prove the feasibility of retrofitting existing high SO_2-NOx emission units with more efficient, low emission AFBC units without the high capital investment associated with SO_2 scrubbers.

7. The Proposed Financing of the Project

The project will be financed by the usual investor-owned public utility methods.

The purpose of the installation is to prove the worth of AFBC in the reduction of NOx and SO_2 in medium and large size utility stations, and to prove the viability of AFBC for retrofitting of existing medium and large size stations. It is expected that the cost of testing will be funded by funds set aside in the U.S. Treasury for Clean Coal Technologies.

This is an operating power plant and not an R&D facility, therefore, system load requirements, not testing, will dictate operating schedules.

NICHOLS #3 CONVERSION TO ATMOSPHERIC FLUIDIZED BED COMBUSTOR OPERATION

Assumptions

1. 1985 dollars
2. Twenty year life remaining
3. Gas cost = $3.32/MMBtu
4. Coal cost = $1.77/MMBtu
5. Fuel cost differential will remain constant
6. Present heat rate = 10,350 Btu/KWH
7. New heat rate - 11,200 Btu/KWH
8. Coal to be conveyed from Harrington - approximately 5000 ft
9. Limestone handling to be at Nichols
10. Ash disposal to be a new site near Nichols Station
11. Inflation rate = 5%
12. Capacity factor as coal fired = 70%
13. Capacity factor as gas fired = 39%

Capital Expenditures

A.F.B.C.	$63,282,171	
Baghouse	5,675,000	
Limestone Facility	4,195,000	
Ash handling System	2,995,000	
Conveyor System	6,795,000	
Plant Modification	1,412,000	
Soot Blowing Systems	660,000	
Ash Disposal Area	500,000	
Stack (in A.F.B.C.)		
Railroad Siding (in Limstone Facility)		
Electrical	678,000	
Overheads	335,900	
A.F.U.D.C.	15,120,000	
TOTAL		$101,684,071

Atmospheric Fluidized Bed Combustor

Generate 1,741,945#/hr of steam
Estimated Cost: 1#/hr - $20
1,841,945 x 20/#1hr - $34,838,000

Erection Costs:
Estimated: $13.25 per pound of steam generated
1,741,945 x 13.25 - $23,808,771

Structural Steel
Steel 1500 tons @ $950/ton = $1,425,000
Labor 1500 tons @ $425/ton = 712,000
$2,137,500

Draft System		
FD and ID Fans and Ducting	$1,250,000	
Boiler Building Enclosure	$1,100,000	
Stack	$ 975,000	
TOTAL		$ 63,282,171
Baghouse		
Baghouse Proper	$1,780,000	
Baghouse Structure	95,000	
Insulation and Lagging	675,000	
Ductwork, etc.	925,000	
Erection Labor	2,200,000	
TOTAL		$ 5,675,000
Limestone Facility		
Material and Labor	$1,120,000	
Crushing Equipment	535,000	
Transporting Equipment	150,000	
Storage and Feeders	1,550,000	
Control Room* and Controls	550,000	
Railroad Spur		
2000 ft. @ $150/ft	300,000	
TOTAL		$ 4,195,000

* Control Room large enough for ash handling and coal conveying controls.

Ash Handling System		
Flyash System	$ 750,000	
Piping Valves, Tanks	250,000	
Vacuum Producers	295,000	
	$1,295,000	
Bottom Ash		
Piping, Valves, Tanks	$ 500,000	
Labor	250,000	
Ash Disposal	800,000	
	$1,550,000	
Control	$ 150,000	
TOTAL		$ 2,995,000
Coal Conveying, Crushing, Handling		
Coal Conveyor		
5000 ft @ $975/ft =	$4,625,000	

Crushers and Handling		
Crushers	120,000	
Silos and Feeders	1,550,000	
Piping, Valves, etc.	350,000	
	$2,020,000	
Controls	150,000	
TOTAL		$ 6,795,000

Plant Modification

HP Boiler Feed	$ 225,000	
Main Steam	475,000	
Hot Reheat	220,000	
Cold Reheat	95,000	
Boiler Blowdown	70,000	
Fuel Gas	65,000	
Control Room	120,000	
Chemical Feed	47,000	
HVAC	35,000	
Inst. Air	20,000	
TOTAL		$ 1,412,000

Soot Blowing System

Compressors	$ 450,000	
Enclosure	135,000	
Piping and Tanks	75,000	
TOTAL		$ 660,000

Electrical

Boiler Area	$ 346,000	
Baghouse Area	102,000	
Soot Blower and Comp. Area	62,000	
Limestone Handling Area	68,500	
Ash Conveying Area	42,500	
Coal Handling Area	57,000	
TOTAL		$ 678,000

Operating Cost/Year - Gas Fired

$$(234{,}000\ \text{kw})(8000\ \tfrac{\text{hr}}{\text{yr}})(\$3.32\ \tfrac{1}{10^6\ \text{Btu}})(10{,}350\ \tfrac{\text{Btu}}{\text{hr}})(0.39\ \text{CF}) =$$

TOTAL $ 25,087,000/yr

Operating Cost/Year - Coal Fired

$$(234{,}000\ \text{kw})(8000\ \tfrac{\text{hr}}{\text{yr}})(\$1.77\ \tfrac{1}{10^6\ \text{Btu}})(11{,}200\ \tfrac{\text{Btu}}{\text{hr}})(0.70\ \text{CF}) =$$

TOTAL $ 25,606,264/yr

Additional Operating Costs

Additional Maintenance Personnel - 6
Additional Operating Personnel - 5

8 x $22/hr x 40 hr/week x 52 weeks/hr = $ 732,160/yr

Limestone Costs/Year

4/2 tons/hr x 8000 hr/year x $25/ton = $ 840,000/yr

O&M -	$366,080
Limestone -	840,000
TOTAL	$ 1,206,080/yr

ATTACHMENT A

	Black Thunder
Btu/lb	8,500
PROXIMATE	
S	0.34
Moist	28.00
Ash	4.90
Volatile	32.20
Fixed C	34.90
ULTIMATE	
C	50.00
Hydrogen	3.54
Nitrogen	0.69
Chlorine	0.01
Sulfur	0.34
Ash	4.90
Oxygen	12.52
Moisture	28.00
TOTAL	100.00
Equilibrium Moisture	25.00
Grindability	53.00
Mineral Analysis of Ash	
P_2O_5	1.00
SiO_2	29.70
FeO_3	5.00
Al_2O_3	15.20
TiO_2	1.10
CaO	23.60
MgO	5.00
SO_3	15.90
K_2O	0.30
Na_2O	1.00
Undetermined	2.20
TOTAL	100.00
% Alk. Na_2O on dry basis	0.08

	BLACK THUNDER
Ash Temp. °F	
Init. Def., Red	2170
Init. Def., Oxi	2210
H = W, Red	2200
H = W, Oxi	2250
H = W/2, Red	2230
H = W/2, Oxi	2270
Fluid, Red	2260
Fluid, Oxi	2310

CLEAN COAL TECHNOLOGY RESERVE

A NATIONAL PRIORITY

SUBMITTED BY

THE EDISON ELECTRIC INSTITUTE

TO THE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES

CLEAN COAL TECHNOLOGY RESERVE

A NATIONAL PRIORITY

On behalf of the Edison Electric Institute (EEI), we welcome the opportunity to discuss the potential role of clean coal technologies as a supply option to provide for the continually growing demand for electricity. EEI is the association of electric companies. Its members serve 96 percent of all customers served by the investor-owned segment of the industry. They generate approximately 75 percent of all electricity in the country and service 73 percent of all ultimate customers in the nation. We appreciate the willingness of the Committee to conduct this timely and important hearing.

SUMMARY

The evolution of the forces affecting utility planning has made the characteristics of the alternative clean coal technologies of great interest. Current circumstances, however, may prevent full utilization of the benefits which these technologies offer.

During my testimony today I will describe the need for new capacity, the resource options being implemented to balance supply and demand, the investment planning considerations, and other technology options available to electric utilities. The advantages of using clean coal technologies to advance the list of generating options for providing power in the future include:

- Environmental benefits of reduced SO_x, NO_x and particulate removal on a cost-effective basis
- Modular Construction
- Wider Fuel Selection
- Improved Efficiency and Availability
- Greater Coal Utilization

This program provides a unique opportunity for technology to drive regulation based upon marketplace rather than regulatory criteria. As an incremental investment banker in these projects, the federal government has a unique opportunity to reduce the risk of technology demonstrations.

NEED FOR NEW CAPACITY

The past 15 years have been tumultuous ones for energy and electricity. Twice, oil imports were curtailed--first, by the embargoes and second, by the Iranian revolution. Also, we should not forget that during the mid-1970's natural gas curtailments led to unemployment. The promise of nuclear power has been tarnished by well-publicized problems affecting some plants. And, of course we all know what happened to prices of all forms of energy. These events reduced economic growth, contributed to the changing structure of the economy, and affected our personal behavior and attitudes.

Now, because we appear to be in a period of energy stability, there is a danger of complacency. Oil, natural gas, and coal supplies are abundant and market prices soft. For most electric utilities, construction programs are coming to an end. In addition, new electricity supply sources and demand side management are growing. It is unlikely that we will return to former use patterns and high consumption growth.

However, this appearance of stability offers little solace to electric utility planners. Because more moderate growth continues and because construction leadtimes in this industry are so long, difficult planning decisions for adequate power supplies in the 1990's must be made soon. New capacity is needed to support economic growth, to provide for retirement of plants, and to reduce dependence on oil and gas.

Virtually all forecasters expect continued growth in electricity demand. Most long-run forecasts for electricity consumption growth fall in a range of 2.0 to 4.0 percent per year. The electric utility industry is planning for growth in consumption of 2.7 percent and growth in peak demand of 2.5 percent over the next decade. This implies a 30 percent increase in consumption over that period. These growth rates, although low by long-run historical standards, represent a continuation of the relative growth trends of energy and electricity. Since the oil embargo, annual total energy use has actually declined while electricity sales have risen 34 percent over this 12 year period.

The fraction of energy use accounted for by electricity will continue to grow. In 1950 electricity accounted for 15 percent of total energy use. By 1960 the share was 19 percent. As we reached 1970 and 1980 it rose to 24 percent and 33 percent respectively. The share is expected to rise to over 40 percent in the 1990's. Coal's contribution to electricity production is also expected to increase.

As plants grow older, just like any industrial facility, they must be replaced. With fewer new plants coming on line, the average age of facilities in place will be rising throughout the balance of the 1980's. While the effects of aging can be mitigated by appropriate investments and plant-life can be extended in some cases, the plants must ultimately be replaced.

In some cases new capacity is also needed in order to reduce dependence on high-cost oil and gas, especially imported oil. Since the 1973 embargo, electric utilities have reduced oil consumption by over 50 percent and gas consumption by 20 percent. Most energy analysts agree that utilities should continue to work toward becoming less dependent on these high-cost fuels.

Not only is there a consensus that new capacity is needed, there is also wide agreement about when it will be needed. Approximately 131 gigawatts (GW) of generating capacity are planned to come on line from 1984 to 1993. This is equivalent to approximately one new large plant each and every month for the next ten years. Even with this expansion program, sometime in the early 1990's peak electricity demand is expected to exceed installed capacity.

We concur with the conclusions drawn by the Department of Energy in publication DOE/IE0003, Staff Report Power Supply and Demand for the Contiguous United States 1984-1993. This publication states that there is "potential for inadequate power supply in some regions" during the 1991-93 period even assuming all planned capacity is brought on-line as scheduled.

Without question, uncertainties surround all of the factors affecting the need for new capacity. Yet, projecting a plausible range of very modest growth rates and projecting a minimum level of replacement of aging and high-cost facilities, some new capacity above and beyond what is already planned will be required in the 1990 to 1995 timeframe. There is a continuing need for new generating plants and the critical planning focus is now on the early 1990's.

Utility Investment Planning Considerations

The economic and regulatory environment in which utilities operate affect the choice of resource options which will be selected to meet this need for new capacity. Conditions today favor selection of technologies with certain characteristics.

Expectations are for electricity sales to grow near or slightly below the growth of the economy. Although some years will exhibit strong growth (for example, sales were up 5.6 percent in 1984), new capacity will need to be added at a slower rate than in the past. For many utilities, increments of new demand are smaller. The first implication is that needed increments of supply are smaller, as well. A second implication is that a planning error on the high side is not quickly corrected by high growth. A given increase in supply takes longer to be absorbed by growing demand than in the past. Nor can a planning error on the low side be quickly corrected. Consequently, increments in supply should closely match increments in demand.

The cost characteristics of generating electricity today reinforce this point. Previously, the addition of a new generating plant actually lowered the unit cost of electricity. Productivity improvements and learning curve effects made economics of scale the rule. Building ahead of demand actually lowered costs. The situation is now reversed. The next kilowatt is more expensive than the last and cost recovery has become contentious. Any deviation between increments of demand growth and increments of supply growth can be a source of economic and regulatory problems for the company involved.

Financial exposure when adding new capacity is now a daunting consideration. In some cases, the cost of adding a baseload generating plant can exceed the net worth of a company. Frequently construction is a threat to the financial standing of a company. Company expenditures rise, costs must be carried until the time the plant goes into service, and cost recovery with a competitive return is not assured. Financial incentives are to forego construction if at all possible. Electricity sales may be slowed by escalation in world oil prices. Changed standards for environmental controls and revised regulatory treatment pose potential financial threats against the earnings of a utility. Along with reduced sales, these factors may result in earnings levels which can not support technology commercialization. Commercialization of a new technology is limited by these financial factors and the uncertain treatment of the financial risk by public utility commissions.

Finally, the real crux of the planning problem that can cause a mismatch of supply and demand is the lead time necessary to respond to uncertain forecasts. Uncertainty is inescapable. But, the lead time problem is controllable. Many of the problems of the industry would be greatly mitigated by shortening the time from the decision to build a plant to commercial operation. Existing short lead time technologies can be selected. Today such technologies are limited to high cost oil and gas turbines. Because of the incentives not to build new plants, there is a danger that this choice will be made by default to satisfy the demands of the 1990's. New clean coal technologies may offer an opportunity for reduced construction lead time.

In summary, we are now in a slower growth, rising cost planning environment. The strategic implications of this are: (1) to build smaller scale plants relative to the past; (2) to consider renovating existing facilities; (3) to add capacity which better tracks demand growth and fluctuations; and (4) to select technologies with a higher ratio of variable to total costs.

The Technology Options

Utilities have a number of supply options with which to meet growing demand. Current technologies can meet future demand. But, current planning considerations compel a search for new options. A quick review of conventional choices illustrates the point.

Because of a decade's accumulation of regulatory, management, and public decisions, the promise of nuclear power is now eclipsed for any utility needing additional capacity before 2000. Under present regulatory and institutional arrangements, American electric utilities are not evaluating ordering nuclear plants. The cost and risks of nuclear development in the United States presently tend to price it out of the current market.

Conventional coal technology, although capable of filling the need, comes with its own set of problems. Coal plants can satisfy all existing and proposed environmental regulations; but, the cost is high. Currently, 34 percent of the physical cost of a plant is for environmental control. Also, economies of scale make an efficiently sized plant too large for the demand increments of many utility systems. Finally, the conventional method of burning pulverized coal is technologically mature. There have been no significant improvements in heat rate (coal burned per kilowatthour produced) in many years.

Other options are becoming a part of utility resource plans. Utilities are buying power from third-party producers (cogeneration and small power production). Utilities are also actively pursuing other non-conventional generating technologies such as low-head hydro, wind, geothermal, biomass, solar thermal, photovoltaics, and fuel cells. The costs and technological risks associated with these technologies place limits on their development over the next decade.

Although the focus today is on generating capacity, we should also note that utilities are pursuing demand-side management. These techniques can hopefully give us some control over the timing of capacity needs and modify demand to allow efficient use of capacity that is in place.

THE BENEFITS OF CLEAN COAL TECHNOLOGIES

There are a variety of technical benefits to clean coal technologies including modular construction, short construction lead times, environmental enhancements, wider coal selection, and improved efficiency in the conversion of raw BTU's to electricity which address the challenges described above. All of these are important national benefits also.

Environmental Benefits

Environmental quality is a public benefit that has been a goal of governing policy for years. The inherent characteristics of clean coal technologies lead us to believe that the environmental benefits will be significant. Clean Coal technologies appear to have the potential to reduce emissions levels more than existing technologies. Table 1 below indicates the emissions control potential associated with these technologies:

TABLE 1

EMISSIONS CONTROL POTENTIAL

Technology	SO_x (% removal)	NO_x ($lb/10^6 Btu$)	Particulate ($lb/10^6 Btu$)
Conv PC/FGD* 1	90-98	0.5-0.6	0.03
AFBC 2	90-95	0.2	0.01
Adv PC/FGD 3	90-95	0.2-0.3	0.01
PFBC 4	90-95	0.1	0.01
GCC 5	90-99	0.1-0.3	0.003
Fuel Cell GCC	99+	0.003	nil
Slagging Combustor 6	90-95	0.1	0.01

* New Source Performance Standards (values listed are legal maximum emissions--not the potential)

1 Conventional Pulverized Coal with Flue Gas Desulfurization (FGD)

2 Atmospheric Fluidized Bed Combustion

3 Advanced Pulverized Coal/FGD

4 Pressurized Fluidized Bed Combustion

5 Gasification Combined Cycle (GCC)

6 Limestone injected with Staged Combustion/Baghouse or ESP

For varying technologies, these potential benefits may be realized either on new generating capacity, or through the retrofit of existing sources to meet demands for reducing emissions from existing coal-burning power plants.

All of these potentially offer significant advances over current technologies. Of the advanced technologies, performance data are available only on the gasification combined cycle system now being demonstrated in California. After 10 months of operation, the SO_x and NO_x emissions are well within the design standards of the plant and are significantly lower than existing coal-fired plants with flue gas desulfurization systems. While this is only one plant relying primarily on one type of coal, we believe it offers significant insights into the potential of these technologies in both new and retrofit situations to utilize all qualities of coal in environmentally acceptable ways. Because several technologies appear potentially to offer similar reductions in emissions, all of these technologies need widespread demonstration to enable our industry to evaluate adequately the most cost-effective technology.

Current Flue Gas Desulfurization (FGD) technologies represent economic costs to our industry. EEI's Construction Committee has estimated that FGD adds 34 percent to the cost of new coal-fired power plants. FGD systems are complex chemical engineering facilities that are difficult to apply to existing facilities. According to EPRI calculations, maintenance costs for FGD systems are two to twenty times the maintenance costs for the rest of the power plant. Difficulties with FGD systems have reduced the availability of coal-fired power plants, thereby adding to utilities costs. Clean coal technology demonstrations, including less costly and more reliable FGD systems, offer an opportunity for utilities to evaluate the effectiveness of new technologies in meeting national environmental goals.

Technology Driving Regulation

An important element of the federal role is to assure that technology drives regulation in industries where that is appropriate. I have noted above the high cost and unreliable nature of current flue gas desulfurization systems. It would be indeed unfortunate if that system were to be the only technology choice for burning coal in an environmentally acceptable manner. We believe that the thorough demonstration of these various high-technologies offers us a potential to demonstrate the best means for environmental control based upon technology performance. Cost-based performance and selection, rather than a regulatory-imposed selection, can provide the most cost-effective benefits to the American people. Technology selection would apply to our industry's need at a plant to be retrofitted or a new one.

Modular Construction

New technologies are characterized by modular construction techniques. This results in fabrication of the system components off-site and transportation to the plant location by truck, barge, or rail. Modular construction may also result

in parts of a system being brought on line at different times to meet elements of growing load demand. For example, a turbine might be brought on line fueled by oil or gas as the first element of a combined-cycle plant; later the turbine would use fuel produced by the plant after plant construction. In this way, modular construction is able to assist in meeting rapid growths in electric demand.

One particular advantage of modular construction is that rapid assembly is possible. To date, the Cool Water Gasification Combined Cycle Plant in California is the most prominent example of modular construction. Due to its modularity, it was constructed in 28.5 months from ground-breaking to the time of operation. This construction time of under 2.5 years is about one-third that of a conventional coal-fired generating station. Shorter construction times make it possible for utilities to respond more precisely to changes in demand thereby reducing construction costs as well as financial risks. In the case of Cool Water, the actual cost was $31 million below estimated costs. Modular construction would result in power stations resembling a chemical plant, and like chemical plants, they would be available in different sizes.

Wider Fuel Selection

Today utilities frequently design a boiler to burn a coal with specific qualities. The entire plant is designed around parameters of the coal such as heating value, ash, sulfur, and trace metals contents. Clean Coal technologies, particularly gasification combined cycle and fluidized bed systems, appear to offer the potential to use a broader range of coals. They would permit wider competition in the coal market to serve utilities and industrial customers. The entire coal market would potentially be increased because coal could be used where environmental standards may otherwise preclude it.

Improved Efficiency and Availability

The technology of burning pulverized coal has been in existence, essentially unchanged, for about the last 50 years. Improved thermodynamics in the conversion process of coal to electricity assist in raising generating station efficiency and lowering electricity cost. New technologies can become the basis of improved efficiences because of the various means that offer enhanced thermodynamics.

Similarly, because these plants are modular and may be built in series, repairs and maintenance of a system component may not shut the entire plant down as is likely to today. Instead, it is possible that throughputs of a production stream can be increased to compensate for a shut-down component resulting in power production remaining at the same level. This will lessen the

risk that a single plant component would be able to shut down a single unit or plant. Through these techniques, the availability or time the plant is producing power can be increased which reduces the amount of capacity needed to meet electrical load. Overall, this has the potential of reducing financing costs for plants not used regularly.

Regulatory Agency Limitations

Federal Energy Regulatory Commissioner Charles G. Stalon has noted that state regulatory agencies have limited abilities to approve utility expenses that are incurred beyond the narrow definition of producing utility services. He concluded that the processes of regulatory agencies are not designed to make good decisions on research funding.

Current regulatory policies for the most part impede the recovery of costs associated with the commercialization of clean coal technologies. This requires utility companies to shoulder significant financial burdens.

The Chief Operating Officer of Virginia Power Company, Jack H. Ferguson, observed in February that, "Without Federal support we could easily have a situation in which utilities will not embrace, and their regulators will not permit, new technology until it is demonstrated by another company. Everyone could be waiting for someone else to take the hazardous trek across the desert in search of the fertile lands beyond. That policy could reflect the observation that it is often not the pioneers but the followers who gain the greatest benefits with the least cost. While this may be a prudent approach for each utility and its regulators, it will not be in the best interest of the nation."

As an incremental partner with utilities and private industry, the Federal Government can help assure that this course of action does not occur.

THE APPROPRIATE ROLE OF THE FEDERAL GOVERNMENT

Unquestionably the Federal Government should be involved in the development of clean coal technologies.

If it is in the national interest to further technologies such as clean coal combustion, then the government must consider moving down the road from generic R&D toward commercialization. Government participation can help overcome technical, financial, and institutional barriers and enrich the choices for commercialization. Federal involvement should be structured along the lines of an investment banker where funds are advanced to specific parties for demonstration of promising technologies.

There is a guarantee of a stream of information that indicates whether a certain technology is cost-competitive when applied to utility scale applications. The information stream is probably most important for our industry for future planning for the retrofit of old plants and construction of new ones.

Government support for this program should not stop at the proof of concept scale as currently advocated by the DOE, but should be carried through the stage of commercial demonstration. The Energy Research Advisory Board (ERAB) has correctly noted the difficulty in bringing many of these clean coal technologies into full-scale utility application.

CONCLUSION

Clearly the advantages of clean coal are substantial. Some of these advantages such as modular construction are reflected in the investment decision process and will be captured by electric utilities and their customers. Others, particularly the environmental benefits of SO_x, NO_x and particulate removal, reflect larger public concerns. It is the responsibility of the government to assure achievement of these benefits for both new and retrofit applications.

To do that, the government must focus on two issues. First, it must act now. The decision window for planning facilities which will be needed in the 1990's is now. Without prompt action the probability of additional conventional facilities is greater. Without prompt action the United States will be handicapped in world technology competition.

Second, the government must recognize the role it can constructively play to move technology from R&D to commercialization. The primary role is with the private sector. But, when the public benefits are large and not fully reflected in the private investment criteria, then it is the proper function of the government to take action to capture those benefits for the public good.

We appreciate the opportunity to present our views on this program of vital interest to our industry and the health and well-being of our Nation.

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